Innovation ecosystem and New Zealand firms

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Abstract

Innovation is not a zero-sum game or a standalone process. Interactions with partners and ecosystems can form synergies which can improve the effectiveness and efficiency of innovation activities. Understanding the innovation ecosystem in a firm and how it interacts with the external innovation ecosystem will be crucial for synergies to happen. Knowledge transfer and collaboration are examples of activities which if addressed properly can help create the right conditions for innovation. Firm level innovation ecosystem can be shaped better by understanding the elements of interaction and participation with the regional and national innovation ecosystem.

Innovation occurs through the process of recombining and integrating past knowledge and practices in new ways. There is a need to look at the factors which are necessary for successful innovation ecosystems and relate this into New Zealand context to come up with a model which could be replicated by firms in different sectors. It is good to replicate elements from successful models and adopt this as part of the organisation's innovation strategy. New Zealand as a country spends comparatively less amount as percentage of GDP for R&D and private businesses also have low R&D spend. Economic size, scale and geographic barriers exist for New Zealand firms. All these challenges are visible in the three layers of national, regional and firm level innovation ecosystems.

Participatory action research was conducted on two New Zealand firms which included a survey and follow up interview. This was combined with the observational study at the firm to find out the main factors of interaction within the firm and with external innovation ecosystem. Culture, collaboration and knowledge sharing are found to be the key factors which determines the dynamics of the internal innovation ecosystem in a firm. External interactions are found to have positive influence on internal factors and vice versa.

The study looked at all the elements which are important to create a functioning innovation ecosystem. Trust, communication, commitment, absorptive capacity and knowledge spillover are found to be the main characteristic elements of a vibrant ecosystem. There is also evidence of the influence of national identity and culture on the regional and firm level innovation ecosystem. This influence was well evident in the case of New Zealand and its firms.

For firms to develop a successful innovation ecosystem they need to nurture a culture of collaboration and knowledge sharing and create a growth mindset in their employees. This is true for regional ecosystems as well as national innovation ecosystems. There is a huge opportunity for New Zealand firms to develop a synergy through positive cycles of interactions. Knowledge economy asks for more spending on R&D and focus on more value creating exports which will help

a small advanced economy like New Zealand. The country needs to diversify its export basket to add more value-added products and services. This will help the country and its economy to grow and provide more for its welfare measures. Without a systemic change in its innovation and research policy and addressing the productivity paradox it will be impossible for New Zealand to attain the general level of wellbeing the country aspires for the future. Strengthening the innovation ecosystem in New Zealand is a core requirement for the long-term prosperity of the country.

Keywords: Innovation ecosystem, Culture, Collaboration, Knowledge sharing, Absorptive capacity, Knowledge spillover, Knowledge economy

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Abbreviations

ABI	Auckland Bio Engineering Institute
AEP	Airline Engineering and Planning
GDP	Gross Domestic Product
GII	Global Innovation Index
ICT	Information and Communications Technology
IT	Information Technology
MBIE	Ministry of Business, Innovation and Employment
MNC	Multinational Corporation
NZ	New Zealand
NZTE	New Zealand Trade and Enterprise
OECD	Organisation for Economic Cooperation and Development
POAL	Ports of Auckland Limited
R&D	Research and Development
RSI	Research, Science and Innovation
SAE	Small Advanced Economies
SME	Small and Medium Enterprise
STEM	Science, Technology, Engineering and Mathematics

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1.0 Introduction

1.1 Research Background

Without innovation there would be no human progress. The wheel, gunpowder, printing, the steam engine, electricity, the telephone and the internet have all had a profound impact on human development. According to Joseph Schumpeter economic development is driven by innovation through a dynamic process in which new technologies replace the old and he called it creative destruction (Schumpeter, 1982). Innovation involves successful application of new ideas to produce positive results for all the partners involved in the process while keeping customer at the core (Knudsen, 2007). It extends well beyond invention and creativity and requires knowledge of how ideas can be successfully applied. It contributes to economic performance of nations and to organisational competitiveness (Martin, 2012).

Innovation driven competitiveness is critical for a country's long run economic performance (Carayannis & Grigoroudis, 2014). Competitive performance of a nation's economy depends on the formation of intellectual capital and the society's capacity to innovate. They also suggest that concepts of innovation, productivity and competitiveness are inherently related. The more advanced and mature the knowledge economy is, the more knowledge and innovation it can absorb for sustainable growth and prosperity of the region (Dubina et al., 2012).

The study of innovation management is important in understanding the economic, technological and social context in which it occurs (Dodgson, Gann, & Phillips, 2013). Research into innovation management continue to evolve as innovation processes change over time. There are no unified theories in innovation management but various theories explaining different aspects of it. Supporting tools and techniques emerge from academic research and are adopted into organisations. Various management tools are resurfacing as innovation tools and needs to be treated with enough degree of circumspection and caution. One challenge for the study of innovation management is in integrating qualitative findings from case studies with testable findings from quantitative research (Dodgson et al., 2013).

The organisational benefits of innovation are highly dependent on how effectively the risks are managed and managers overcoming the many challenges. Organisations shape strategies and practices to improve benefits of innovation for their respective firms (Lawson & Samson, 2001). They manage innovation by creating supportive structures, practices and processes. Organisations face the challenge of dynamically responding to contextual changes and disruption while creating value for their customers (Yu & Hang, 2011). Dealing with disruption, balancing portfolios,

integrating the innovation process and encouraging creativity are some of the key innovation management challenges faced by organisations.

Ecosystem metaphor could be used to examine a dynamic system comprising of a group of interconnected elements and interactions among actors and between actors and their environment. Silicon Valley is an example of a successful regional innovation ecosystem where there are plenty of interactions and inter-linkages between multiple organisations (Valkokari et al., 2017). The ecosystem approach shows promise for examining management that spans value chains, networks and industry boundaries (Aarikka-Stenroos & Ritala, 2017). In an innovation ecosystem, value creation refers to the collaborative processes and activities of creating value for customers and other stakeholders (Ritala et al., 2013).

The metaphor 'ecosystem' has enjoyed increased popularity in academia, industry, policy, and management as a vehicle to describe how economic agents interact with their environment (Audretsch et al., 2019). Strategic and competitive advantages are increasingly based on shared resources and knowledge spillovers which are available in an innovation ecosystem. In knowledge spillover entrepreneurship, entrepreneurs create new firms to commercialise external knowledge (Qian, 2018). Innovation can emerge from partnerships between R&D institutions and industry, where work on a project produces spin-off ideas that produce new and often unexpected developments. The innovation ecosystem has interactions at many levels and may involve iterative organic processes rather than a simple linear model.

The innovation ecosystem is an emerging concept. The innovation ecosystem is a concept adopted from biology, where an ecosystem refers to "a complex set of relationships among the living resources, habitats and residents of an area, whose functional goal is to maintain an equilibrium sustaining state"(Su, Zheng, & Chen, 2018). A biological ecosystem is modelled by tracing the energy exchanges across the system while an innovation ecosystem is characterised by the flow of knowledge and resources between different actors in the system.

Innovation ecosystem is defined as a locus where organisations combine internal innovations with external innovations to optimise their product profitability (Ferasso, Takahashi, & Gimenez, 2018). It supports the embedded organisations to develop innovation and technology through an interorganisational strategy of collaborations. The innovation ecosystem boundaries are not geographically limited but through the relationships that the ecosystem organisations maintain with their partners these boundaries can extend worldwide.

1.2 Research Motivation

The immediate research motivation came as a result of interaction with the Auckland regional innovation ecosystem and with entities as part of the local ecosystem. After careful analysis of the available literature, it was found that there is a lack of study and analysis done with the ecosystem mindset. It was also observed that there is considerable potential in developing innovation ecosystems as shown by successful ecosystems abroad, most notably Silicon Valley in the USA. Considering the small size and population of New Zealand, it is advisable to look at regions and countries with comparable population and demographics.

New Zealand economy is mainly dependent on traditional industries and it requires a transformation in order to sustain itself in the future international trade. There are examples of small advanced economies which have done the same, transforming itself from traditional agricultural based economies to world class knowledge economies. This transformation requires innovation and therefore it is important to create an ecosystem which supports innovation. This ecosystem can extend from the firm level to regional and national level. Hence it is important to involve different firms as part of the study.

This thesis intends to define innovation ecosystems in a structure that countries like New Zealand can use to establish their own ecosystem in order to reap the advantage of innovation. In order to do that there are several steps that need to be done:

1) Before proceeding any further with the study, it is required that a systematic study of the current literature on innovation ecosystem is done so that the subject is properly defined and the current gap in the literature is highlighted. This study is undertaken in chapter 2 of the thesis. Analysis of Auckland Regional innovation ecosystem is also done as part of the initial literature review.
2) The initial study has to look at New Zealand country statistics in relation to innovation, economy, trade and how it compares with other regions. This detailed analysis is done in chapter 3 where New Zealand innovation ecosystem is compared and contrasted with other successful innovation ecosystems. The main gaps in the New Zealand innovation ecosystem are analysed and the potential for improvement is shown.
3) Identify organisations to study the local innovation ecosystem and to understand the dynamics of interaction between the firm, regional and national innovation ecosystems. This study is done in chapter 5 of the thesis.

1.3 Thesis Organisation

This thesis is organised in nine different chapters as shown in figure 1-1 and in order to achieve the study objectives, both fundamental research and practical case studies are conducted and presented.

Chapter 1 introduces the topic of innovation ecosystem and show the growing importance of the 'ecosystem' metaphor in innovation management research. It then provides research motivation and an introduction into how the thesis is organised.

Chapter 2 provides a thorough literature review on innovation, corporate innovation, innovation ecosystem and discuss about the ecosystem metaphor which is used in this study. This chapter also looks at regional innovation system models and specifically focus on triple helix innovation model as a theoretical example. It then takes a deeper look at the Auckland regional innovation ecosystem and present the important actors in that ecosystem.

Chapter 3 looks at the New Zealand research and innovation systems particularly at the policy level. Several published reports, both national and international, are considered to frame the argument. This chapter is important from the ecosystem viewpoint where national culture and innovation leadership may have an effect on the regional and firm level dynamics. This is done to provide context for the study instead of analytical contribution.

Chapter 4 looks at research gap and scope of research along with the research methodology. This chapter prepares the groundwork for the participatory action research which is the core area of this study. Reasons for following the research methodology is given along with a critical analysis of different models. Research design is presented.

Chapter 5 is devoted to the participatory action research on two large New Zealand firms located in the Auckland region. This case study approach gives a very insightful account of the effect of innovation ecosystem activities inside the organisation as well as the interactions with outside partners and other New Zealand entities. The internal and external interactions within the firms and outside the firms is central to this thesis.

Chapter 6 has another detailed literature analysis based on the findings from the case studies. This is in spirit with the participatory action research methodology where follow up literature analysis is undertaken at different stages of the study.

Chapter 7 is a discussion chapter which looks at findings from the case studies, detailed literature analysis and the country level policy framework and summarises the findings. This chapter presents

a model framework for the creation of innovation ecosystems in a firm level as well as at a regional and national level.

Chapter 8 of the thesis deals with recommendations where it explains the fundamental elements of an innovation ecosystem which could be applied in a firm level as well as in a regional and national level innovation ecosystem. The required changes to the innovation policy for the country is explained in this chapter.

Chapter 9 concludes the thesis and it also looks at the research impact and some of the limitations of the study.

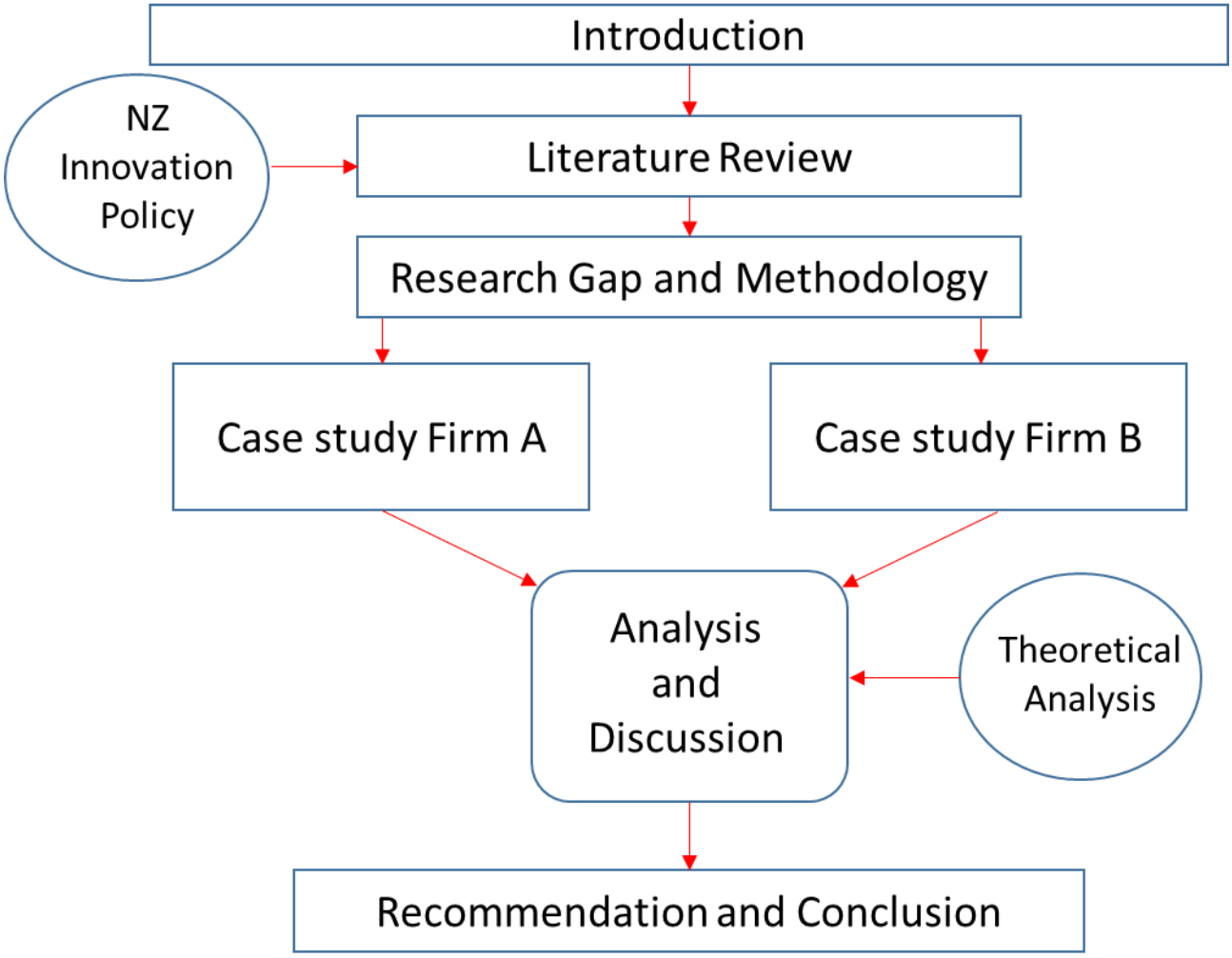

Figure 1-1 Thesis Structure

2.0 Literature Review

2.1 Innovation

An innovation is not an isolated event but the end result of ideas and experiments of previous innovative efforts (Edgerton, 2010). Most innovations are novel combinations of elements that already exist (Schumpeter, 1942). In order to kick start innovation and reap its benefits, one must recognise that innovation is a process and a mindset (Kahn, 2018). Innovation as a process includes an overall innovation process and a new product development process. Innovation as a mindset addresses the internalisation of innovation by individual members of the organisation. Mindset aligns employees and manifests the culture needed for innovation to happen. It is about instilling a mindset that prepares the individual and organisation so that there is proper engagement in the innovation process.

Factors needed for continuous innovation are an innovation leadership by management, an innovation-oriented culture, competent and committed individuals with a passion to innovate, leaders who empower and an ambidextrous organisation (Steiber & Alänge, 2013). Nearly every successful innovation occurs at the intersection of a valuable problem to solve, a technology that enables a solution and a business model that generates profit from it (McKinsey & Company, 2015). Various factors have to come together for innovation to occur. Thus, it is important to create the right environment for various constituents to come together for a positive outcome.

Most of the corporate investment is directed towards incremental innovation. Unless forced by competitive pressure the corporate strategy and management effort favours incremental over any radical process change. Industry experts often fail to see the radical innovations within their sectors (Christensen, 2006). The exponential nature of technology changes and the advent of digital technology has increased the pace of innovation. For an organisation to survive in this new scenario it requires a management structure which is dynamic and more agile in nature.

Innovation comes in three forms (Mezue, Christensen, & Bever, 2015). “Sustaining innovation” to replace old products with new and better ones and “efficiency innovation,” which allow companies to make and sell established products or services at lower prices. The third type is “market-creating” innovation which create products and services that are cheap enough and accessible enough to reach an entirely new population of customers. This type of innovation is the most difficult, have higher risk profile and it requires market disruption and a new way of thinking.

Disruptive innovation as defined by Christensen is one in which a new player eats away at the low end of an incumbent’s market with a lower quality product (Christensen, Raynor, & McDonald,

2015). After taking root in a simple manner, disruptive innovations get better over time and move previously dominant firms to the side lines (Christensen, Raynor, & Anthony, 2003). Over the long term, the greatest innovation risks a company can take is not to create new businesses that decouple the company's future from that of its current business units (Christensen, Bartman, & Van Bever, 2016).

Collaborative efforts support and facilitate the innovation management process (Hidalgo & Albors, 2008). Teece, Pisano and Shuen (1997) define dynamic capabilities as the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments. The term 'dynamic' refers to the capacity to renew competences with the changing business environment. The term 'capabilities' emphasises the key role of strategic management in appropriately reconfiguring internal and external organisational skills, resources and competences to match the requirements of a changing environment. A number of conceptualisations of innovation related systems are introduced, such as national, sectoral, regional and corporate innovation systems (Granstrand & Holgersson, 2020).

In the following part of this chapter a literature review is undertaken on corporate innovation, ecosystem thinking in innovation research and implications of using this metaphor for the study of innovation. The literature review is done as a prelude to the participatory action research on innovation capability in firms and the effect of regional ecosystems. Various interpretations of innovation ecosystems are studied and discussed.

2.2 Corporate Innovation

Corporate entrepreneurship has evolved to become a strategy that can facilitate firms' efforts to create innovation and growth (Kuratko, Hornsby, & Hayton, 2015). It needs a sustained and strong commitment from all levels of the organisation. The process of thinking innovatively is not natural to most traditional firms. For corporate innovation to be successful, entrepreneurial activity must be carefully integrated into the organisation's overall strategies. Research on corporate entrepreneurship and innovation demonstrates that there are some key issues that most corporations are not responding effectively. This include understanding the type of innovation, coordinating managerial roles and properly training and preparing employees (Kuratko, Covin, & Hornsby, 2014). If these issues are properly addressed, it can help to create an effective innovative ecosystem within the organisation.

Ireland, Covin and Kuratko define corporate innovation strategy as organisation wide reliance on entrepreneurial behaviour that continuously rejuvenates the organisation through the recognition

and exploitation of entrepreneurship (Ireland, Covin, & Kuratko, 2009).Two elements that support corporate innovation are an entrepreneurial strategic vision and a pro entrepreneurship organisational structure. They help organisational members commit to entrepreneurial behaviour and empower them for innovation related activities. Researchers have suggested that the pursuit of corporate entrepreneurship requires established companies to strike a delicate balance between engaging in current operations while at the same time embark upon new activities and opportunities (Ahuja & Morris Lampert, 2001).

Corporate innovation is a process that can enable the firm to innovate constantly and deal effectively with the competitive landscape. Corporate entrepreneurship flourishes in established firms when individuals are free to pursue initiatives. Research has identified five factors that are important determinants of an environment conducive for corporate innovation: top management support, work autonomy, rewards, time availability and organisational boundaries (Kuratko, Hornsby, & Covin, 2014).

Entrepreneurial outcomes at the organisational levels result from using entrepreneurial behaviour as the foundation for implementing a corporate entrepreneurship strategy (Ireland, Kuratko, & Covin, 2003). Entrepreneurship and organisational intrapreneurship are the basis of technological innovations and firm renewal (Menzel, Aaltio, & Ulijn, 2007). Individual employees could develop innovative ideas of organisational process from their daily operations (Park, S. H., Kim, & Krishna, 2014). New ventures can start within the organisation if the firm can motivate and facilitate entrepreneurial thinking among employees about their work processes. Intrapreneurial employees will be more likely to seek out and share innovative ideas and knowledge and make their firm more innovative and successful.

Intrapreneurship is the practice of developing a new venture within an existing organisation to create economic value (Parker, 2011). It refers to a process that goes on inside an existing firm and leads not only to new business ventures but also to other innovative activities such as development of new products, services, technologies and strategies (Antoncic & Hisrich, 2001). Firms that nurture organisational structures and values conducive to intrapreneurial activities are more likely to grow than organisations that are low in such initiatives. Intrapreneurial organisations are those that engage in new business venturing, are innovative, continuously renew themselves and are proactive.

The intrapreneur is someone who recognises the opportunities for change and believes that the exploration of a new path will succeed in achieving the objectives of the organisation (Soriano et

al., 2012). The first sign of intrapreneurial talent is generally the ability to spot opportunities (Thompson, Heinonen, & Scott, 2014). Those organisations which have nurtured the intrapreneurial talent have gained from it. Others have seen growing frustration in those employees who wants to grow. Intrapreneurship within organisations is not affected directly by the work context, but indirectly through innovative workplace behaviour and personal initiative by employees (Rigtering & Weitzel, 2013).

Intrapreneurship is more precisely defined by referring to emergent behavioural intentions and are related to departures from the customary ways of doing business in existing organisations (Antoncic & Hisrich, 2003). Changes in organisational routines created through intrapreneurship may become a new routine for the organisation. An organisation may learn how to be entrepreneurial based on its experience with intrapreneurship activities and may engage in intrapreneurship more effectively overtime. The intrapreneur demonstrates an extremely strong sense of 'psychological ownership' that is well beyond the employee mindset (Seshadri & Tripathy, 2006).

An innovation culture attained through intrapreneurial initiatives can lead to considerable organisational development in terms of firm performance, innovativeness, profitability and competitiveness (Baruah & Ward, 2015). If the culture within an organisation is resistant to change and reluctant to experiment with new ideas, then that might discourage the spirit of innovators. Organisational climate and management that fosters collaboration between the people, tolerates risk and supports personal growth and development are all important. Reduction of organisational hierarchy is also important to promote intrapreneurship.

The core concept of corporate entrepreneurship is that organisational change is manageable and that management is in control of the actions of employees (Amo, 2010). Corporate entrepreneurship is initiated from the top. Intrapreneurship is about the implementation of innovations in organisations initiated by an employee in a bottom up way. Corporate entrepreneurship is a top down process and is a strategy that management can utilise to foster more initiatives to achieve improvement from their workforce (Bosma, Stam, & Wennekers, 2010). Intrapreneurship relates to the individual level and is about bottom up initiatives of individual employees.

Employees engaging in entrepreneurial and innovative behaviours are the foundation for organisational innovation (Kuratko et al., 2014). Organisations must establish a process through which individuals in an established firm pursue entrepreneurial opportunities to innovate. Managers at different levels have different roles that provide structural ability to implement

innovative ideas (Hornsby et.al, 2009). Corporate innovation strategies need to be more aligned on each specific managerial level. Senior and middle managers are more likely to implement entrepreneurial ideas. First level managers are relatively unlikely to see their ideas implemented regardless of the level of managerial support.

Transformational leadership has a positive impact on intrapreneurial employee (Moriano et al., 2014). Managers are most effective in facilitating entrepreneurial behaviour within the organisation when they share a sense of mission, encourage employees to think in new ways and gain their trust and confidence. Management support for idea development and tolerance for risk taking are found to exert positive effects on innovative performance (Alpkan et al., 2010). Every employee should feel and know that if they behave like intrapreneurs and develop viable but still risky ideas for innovation and entrepreneurship they will be supported in their firms.

2.3 Innovation Ecosystem

Ecosystem is suggested by Moore (1993) to describe the complex, dynamically changing, symbiotic relationships formed among a network of business organisations (Khademi, 2020). Using the ecosystem analogy, innovation ecosystem consists of interacting populations of actors residing in a certain environment (Durst & Poutanen, 2013). Ecosystems come in various forms and are labelled as business ecosystems, innovation ecosystems, platform ecosystems etc. (Järvi & Kortelainen, 2017). The behaviour of a complex system such as an ecosystem is often surprising and difficult to predict because of its inherent nonlinearity.

Ecosystem is a metaphor used to describe a range of value creating interactions and relationships between interconnected organisations (Dodgson et al., 2013). The term has been used in a variety of contexts and provide insight into the management of innovation in evolving networks of interconnected actors organised around a firm or platform (Teece, 2007). The innovation eco system concept has a distinctive aspect based on its focus on the evolution of networks of interconnected actors towards new states and this process is very dynamic in nature (Gustafsson & Autio, 2011). Ecosystems should be dynamic in their composition and renew themselves constantly.

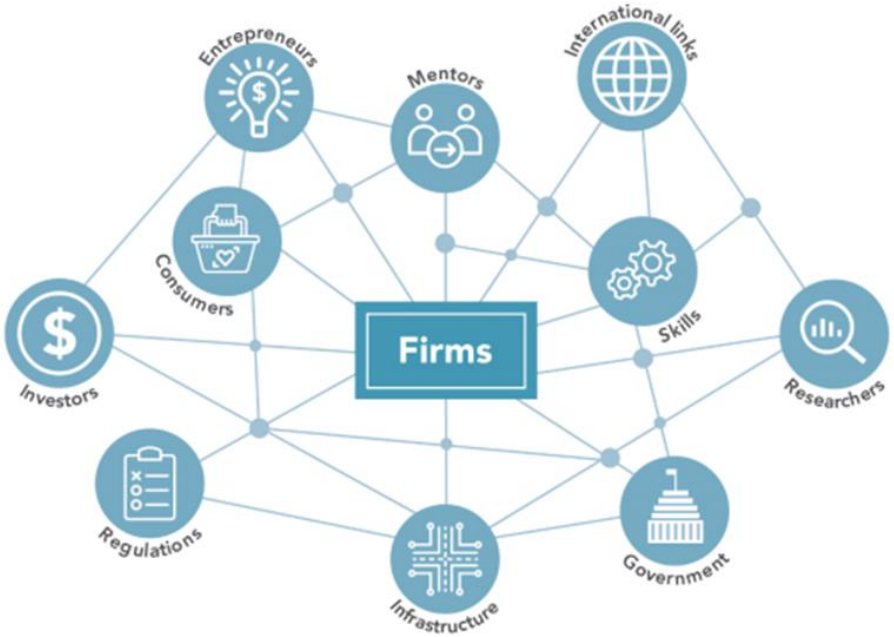

Figure 2-1 Innovation Ecosystem Model (New Zealand Productivity Commission, 2021)

The figure 2-1 above shows a typical innovation ecosystem model where the firm at the centre is supported and linked by other actors in the ecosystem. In innovation ecosystems which has numerous actors in different layers, actor's decisions may cause responses from other actors (Ritala & Almpanopoulou, 2017). Innovation ecosystems are complex adaptive systems and the system gets hardly predictable. Adner (2017) defines ecosystem as the alignment of the multilateral set of partners required to interact for a focal value proposition to materialise. The main theoretical premise for ecosystem research is the simultaneous presence of complementarities and interdependencies between actors (Kapoor, 2018). Organisational strategies will affect the health of its business network which in turn will affect the firm's performance (Iansiti & Levien, 2004b). Knowing what to do requires understanding the ecosystem and the firm's role in it.

Innovation ecosystem models the economic dynamics of the complex relationships that are formed between entities whose functional goal is to enable technology development and innovation (Jackson, 2011). Silicon Valley is a best-known example of a geographically localised ecosystem (Saxenian, 1996). Creating and exploiting innovation ecosystems requires entrepreneurial insight and strategic thinking (Zahra & Nambisan, 2012). A healthy organisational ecosystem should be structured to handle failures as well as successes in order to facilitate more efficient utilisation of ecosystem resources.

Resources, governance, strategy and leadership, organisational culture, technology and interaction between ecosystem actors are key determinants affecting ecosystem performance (Adner, 2006; Wessner, 2005; Yawson, 2009). The core of the ecosystem perspective is that innovation is examined as a part of a system comprising interdependent stakeholders and institutions (Aarikka-Stenroos et.al, 2016). The successful development of an innovation requires support and input from multiple firms, organisations and stakeholders. Mapping ecosystem actors, processes and industry contexts will help managers consider the ecosystems that are relevant for their innovative activities.

Adner and Kapoor stresses the importance for value creation in innovation ecosystems (Adner & Kapoor, 2010). Ecosystem approach includes considerations of challenges that different actors need to overcome to make sure that the value is created in the first place. In an ecosystem each actor has different attributes, experiences and beliefs (Tsujimoto et.al, 2018). Shaw and Allen suggest that innovation ecosystems can be defined as pathways of interlinked business models (Shaw & Allen, 2018). These pathways convey material and informational resources, as well as value.

A vibrant ecosystem can enable activities and capabilities to be constantly reconfigured in response to the system dynamics (Williamson & De Meyer, 2012). The alignment of actors is critical to value creation in the innovation ecosystem (Walrave et.al, 2018). Innovation ecosystems can be described as complex constellations of organisations in which actors interact with each other to create, deliver and appropriate value. A highly developed innovation ecosystem helps participants to operate beyond firm boundaries and enable transfer of knowledge leading into innovation (Mercan & Goktas, 2011). Innovation ecosystems are dynamic structures, and they evolve according to changing market conditions.

Innovation ecosystems can be initiated and managed through conscious intervention (Heaton, Siegel, & Teece, 2019). The creation of strong capabilities involves fostering a collaborative organisational culture and propagating a shared vision. To be successful, the ecosystem must build a critical mass of companies, entrepreneurs, skillset, and investment. Universities can contribute to produce and attract the human capital necessary for innovation. They can also help to generate new knowledge within the innovation ecosystem. A key characteristic of successful innovation ecosystems is that knowledge flows in all directions. Research universities with dynamic capabilities are in a good position to provide strategic leadership for the ecosystem. They can drive the development of new scientific and industrial fields that corporate research is reluctant to explore.

To support the transformation of economies from systems to ecosystems, governments at all levels are now called to nurture an environment that enables continual emergence of new innovative

firms, collaborative networks and triple helix partnerships. Zahra and Nambisan focus on the diverse entrepreneurship opportunities that exist in global innovation ecosystems (Zahra & Nambisan, 2011). Succeeding in rapidly growing global innovation ecosystems requires building connections by exploiting social capital to offset the limitations of existing capabilities. Firms have learned that success also rests in developing and managing their ecosystem to allow them to quickly introduce and commercialise their products as well as innovative business models.

In innovation ecosystems strong interdependence between the members offer synergetic interactions between complementary firms (Scaringella & Radziwon, 2018). When firms establish cooperation and collaborate for shared business objectives the interdependencies between them become more visible. Innovation ecosystems are formed by networks that have advanced from cooperation to collaboration among agents (Russell & Smorodinskaya, 2018). An ecosystem's behaviour and innovativeness are an aggregated result of interactions among its agents. This implies synergy effects that enlarge an ecosystem's productivity to a greater extent than the sum of individual results of its participants.

Management research on ecosystems can be regrouped into three streams the business ecosystem stream which focuses on a firm and its environment, an innovation ecosystem stream which focuses on a particular innovation or a new value proposition and the constellation of actors that support it, and a platform ecosystem stream. The latter considers how actors organise around a technological platform (Jacobides, Cennamo, & Gawer, 2018). Innovation ecosystems differ significantly and multidimensionally from other types of ecosystems (Ferasso et al., 2018) and are attracting a strong and rapidly growing interest among scholars, practitioners and policymakers ((Tsujimoto et al., 2018);(Yaghmaie & Vanhaverbeke, 2019)).

Innovation ecosystems can be classified as macroscopic (collaborating at a national level), medium (focusing on the ecosystem of industrial or regional innovation), and microscopic (analysing activities at the organisational level) (Su et al., 2018). Pombo-Juárez et al., (2017) classified innovation ecosystems at local, regional, national and international levels. Aarikka-Stenroos and Ritala (2017) point to geographical scope, actors, and actor-related issues as a reasoned approach for distinguishing between business, innovation, entrepreneurial, platform and service ecosystems.

Facilitation is needed to support the ecosystem actors to make new connections and to share their knowledge and resources in concrete ways. More diversity among the ecosystem actors means greater support for innovativeness within the value co-creation process (Ketonen-Oksi & Valkokari, 2019). As the complexity and multiplicity of actors participating in these innovation ecosystems

increases, a more dynamic and open dialogue is required from all ecosystem actors to better understand and balance the interplay between them.

Innovation ecosystems should by definition place emphasis on collaboration (Granstrand & Holgersson, 2020). Innovation ecosystems are defined as communities of self-interested, interconnected, interdependent and hierarchically independent participants who jointly create value (Ngongoni, 2021). One characteristic of an ecosystem is that there exists coevolution between the leading ecosystem company and participating companies (Lee & Lim, 2018). Coevolution of ecosystem members is essential for a sustained growth and development of interorganisational ecosystems. The ecosystems whose members experience coevolution will consistently get new members, which will further improve their overall competitiveness.

Innovation ecosystems can be macroscopic (national or international), medium (regional), or microscopic (organisational). Ecosystems can evolve from one level to another through transitions (Sant et.al, 2020). Yung et al., (2020) indicated that significant differences existed in the innovation ecosystem's actors and relationships. There is a strongly positive relation between firms' R&D expenditures and innovations, specifically in products, processes, and technologies that become the driving forces of firms' development and progress (Prokop, Hajek, & Stejskal, 2021). Dynamic capabilities of the firms also played a crucial role in its innovation ecosystem.

Innovation is interdisciplinary, resource intensive and requires a wide spectrum of knowledge, resources, capital and market feedback. Individual companies are rarely able to provide all needed innovation constituents by themselves. Collaboration in an interdisciplinary ecosystem is needed. Collaborative network-based innovation allows an opportunity for ideas to be generated, evaluated and developed collaboratively (Schuh & Woelk, 2017).To enable collaborative innovation an appropriate environment is needed to allow sharing and interacting between partners. However, the design of an innovation ecosystem is not systematically characterised yet and needed elements in the ecosystem are unknown.

Creating an innovation eco system within an organisation can be done by borrowing some characteristics from other successful firms and ecosystems (Hamel, 1999). Silicon Valley is a good example of a successful innovation ecosystem and has consistently produced breakthrough technology innovation and has a habit of doing it multiple times over several decades. Firms like 3M, GE, Johnson & Johnson, Google, Intuit and others have been successful in creating an innovation eco system within their corporate structure. Some of the common factors are: availability of talent, culture of knowledge sharing, collaboration and an environment which nurture

fresh thinking (Smith, 2006). The recipe can be a little different, but each organisation can find what works for them and create their own innovation eco system.

2.4 Ecosystem metaphor in innovation management

According to Asheim (2007), we have evolved from thinking in terms of triple helix model to ecosystem thinking. There are three characteristics of an ecosystem such as a network of participants, a governance system and a shared logic (Gonçalves et.al, 2020). Ecosystem thinking comes close to open innovation in which the actors purposively tap into the inflows and outflows of knowledge by opening the innovation process (Chesbrough, 2012). This will accelerate internal innovations and expand markets for external use of those innovations.

Adner (2006) states that innovation ecosystems can be defined as the collaborative arrangements through which firms combine their individual offerings into a coherent, customer facing solution. The innovation ecosystem is what constitutes a complex set of innovations and communities and interactions between them (Wang, 2009). The unique features of purposeful design and evolutionary nature may make the innovation ecosystem concept viable for examining real world phenomena (Ritala & Almpanopoulou, 2017). By utilising some of the useful features of ecological thinking and systems thinking, innovation ecosystem studies can embrace their research objects more realistically.

Moore (1993) first used the term ecosystems to describe a set of producers and users that contribute to the performance of an organisation. Subsequently, this basic concept has been applied to the field of innovation management and some authors consider the business ecosystem as a synonym for an innovation ecosystem((Gawer & Cusumano, 2014);(Nambisan & Baron, 2013)) . Gomes et al. (2018) presented the main characteristics of and similarities and differences between business ecosystems and innovation ecosystems.

The ecosystem pathways concept can be used to think about the construction of new business ecosystem pathways using interlinked business models. Business models interlink to form pathways that convey value in a similar way to the nutrient and energy pathways in a natural ecosystem. These perspectives can also be used to study interactions between firms with similar or different business models. Allen and Hoekstra use six lenses approach for studying innovation ecosystems from the natural ecosystems' literature (Allen & Hoekstra, 2015). As in natural ecosystems the organising characteristic that makes innovation ecosystems interesting to researchers is their cycling of resources between each other and their external environment.

The idea of ecosystems offers insights on the framing and implementation of further research on innovation. Innovation ecosystem is understood as a smart system having the characteristics of complex adaptive systems (Jucevičius & Grumadaitė, 2014). Innovation ecosystems emerge as supportive environments in the course of collaboration among networked actors (Smorodinskaya et al., 2017). Collaboratively governed ecosystems provide an alternative to the linear type of regional or national innovation systems. Ecosystems offer a systems approach to innovation by focusing on how a network of actors create and sustain competitive advantage to a system of actors who are not hierarchically managed but rather act towards their own goals (Suominen, Seppänen, & Dedehayir, 2016).

The notion of ecosystems offers an attractive metaphor to explore a variety of interactions between multiple organisations in innovation. The interconnectedness and interdependency of innovating firms means that the innovation sector behaves in same ways as a natural ecosystem (Hendy, 2013). Actors are likely to enter the innovation ecosystem at various times across the pioneering phase and also assume a sequence of different roles as the innovation process unfolds (Dedehayir, Mäkinen, & Ortt, 2018). Autio and Thomas define innovation ecosystems as a network of interconnected organisations, connected to a focal firm or a platform and creates and appropriates new value through innovation (Autio & Thomas, 2014). The variety of ecosystem participants makes it difficult to define the boundaries of the ecosystems.

Like an individual species in a biological ecosystem, each member of a business ecosystem ultimately shares the fate of the network, regardless of that member's apparent strength (Iansiti & Levien, 2004a). The ecosystem concept has also been actively discussed in management studies bridging system thinking and evolutionary economics. The primary motivation for utilising ecosystem concepts has been to exploit self-organising properties of natural ecosystems (Valkokari, 2015). As in natural ecosystems the organising characteristic that makes innovation ecosystems interesting to researchers is their cycling of resources between each other and their external environment (Shaw & Allen, 2018). Successful innovation ecosystems are able to adapt to changing circumstances in the broader business and regulatory environment (Heaton et al., 2019). While innovation ecosystems can emerge and grow organically the process can be initiated and then managed through conscious intervention.

A recent study offers a consensual definition of innovation ecosystems by identifying three critical components, that is actors, relationships and artefacts (Granstrand & Holgersson, 2020). Although innovation ecosystem is considered a to be synonymous with innovation network, it is defined as

a locus where organisations combine internal innovations with external innovations to optimize their product profitability. A given innovation, in a context of the innovation ecosystem, is obtained through collaborative–interdependent relationships of agents (firms, universities, government organisations and research centres). Innovation ecosystem supports the embedded firms in a way to develop innovation and technology by an interorganisational strategy of collaborations. An innovation ecosystem is represented by an organic and dynamic structure that a given organisation sustain with various external actors (Ferasso et al., 2018).

2.5 Regional Innovation ecosystem

Regional innovation systems refer to the networks and institutions linking knowledge producing hubs such as universities and public research labs with innovative firms within a region. These linkages allow knowledge to spill over between different organisations thus increasing a region's overall innovativeness. They are formed by networks conditioned by exchange of knowledge and cooperative interaction. Regional innovation ecosystem needs systems and processes to engage people, define shared purpose and create conditions for good collaboration.

A regional innovation system is characterised by collaborative innovation activities between firms and knowledge creating and diffusing organisations such as universities, R&D institutes and technology transfer agencies (Doloreux & Parto, 2005). The factors that can contribute to the eventual success of a regional innovation system are creativity, entrepreneurship, knowledge sharing and constant exchange between the relevant actors of the ecosystem. Much of our understanding of the regional innovation comes from research clusters, industrial hubs or regional innovation systems. They have common characteristics in specialisation, proximity and collaboration that lead to knowledge spill overs and synergies within a regional innovation system.

Cities and regions have been transforming themselves to become more entrepreneurial. Improving competitiveness of a region requires promoting innovation, creativity and entrepreneurship along with a dynamic regional ecosystem (Mulas, Minges, & Applebaum, 2016). According to Cooke (2001a), regional innovation systems play a crucial role between the national and the local level of ecosystems. The model for promoting regional and local economic development based on innovation has major stress on network interactions among various actors in the ecosystem.

Like natural ecosystems each innovation ecosystem has its own individual character. The shift towards a knowledge-based economy requires connecting the various actors of the ecosystem and being constantly on the cutting edge of innovation (*Regional innovation ecosystems: Learning from the EU's cities and regions* .2016). These innovation ecosystems evolve through an interaction

between top down policy measures and bottom up creative forces. It is important to promote interactions between different innovative actors such as firms and universities or research institutes, or between small start-up firms and larger organisations (Cooke, 2001b). An effective regional innovation system is an open system which translates exploration knowledge from inside or outside the system to exploitation knowledge in the form of a commercial innovation (Cooke, 2008).

According to Asheim (2007) , the regional innovation system can be thought of as the institutional framework supporting innovation within a region. The two types of actors such as the knowledge generation subsystem and knowledge exploitation subsystem are systematically engaged in the regional innovation system. Systems approach to innovation denotes that innovations are carried out through a network of various actors connected by an institutional context (Cooke, Philip, Uranga, & Etxebarria, 1997). It is a more holistic approach as information flows in multiple directions in system dynamics. Interaction involves feedback at different points in the innovation process and it involves knowledge development, diffusion and deployment.

Large corporations can effectively integrate into regional networks through knowledge sharing and collaboration with suppliers and customers (Saxenian, 1994). By transcending the distinction between what lies inside and outside the firm it shows possibilities of a complex network of social relationships within and between firms and between firms and local institutions. According to Saxenian, collaboration, openness and lack of hierarchy make Silicon Valley a more vibrant regional innovation system. What distinguish the more successful innovative firms is their ability to connect with and tap into different systems of innovation as a source of competitive advantage. Being part of wide networks provide a variety of knowledge sources that sustains their economic activity.

Innovative performance of regions is improved when firms are encouraged to interact with various support organisations and firms within their region (Doloreux & Parto, 2004). Collaboration between firms in a cluster raises their innovative performance and competitiveness by combining resources and knowledge (T Asheim, Coenen, & Svensson-Henning, 2003). Through collaboration between firms, universities, research centres and policymakers in jointly designing regional development and innovation strategies, trust between the partners can be enhanced. Cultural norms and trust that reward entrepreneurial action will enhance cooperation between the regional actors according to Audretsch and Belitski (2017).

A systems approach to innovation denotes that innovations are carried out through a network of various actors connected by an institutional framework. The unique character of the regional

innovation system is the prevalence of a set of attitudes, values, norms, routines and expectations that influences the practices of firms in the region (Asheim, Bjørn T. & Coenen, 2005). This common regional culture shapes the way firms interact with one another in the regional economy. Diverse cities provide a platform for greater networking and communications, facilitating information and knowledge exchange. This may generate new ideas and speed up knowledge and information diffusion.

Regional innovation system is a more generic concept than clusters and provides a more comprehensive policy framework (Asheim et al., 2011). Knowledge transfer is a key variable shaping regional innovation performance. The efficiency of the knowledge transfer system, education and training, the availability and mobility of skilled labour and public policy measures determines the final output of the system. The extent of knowledge transfer is not limited exclusively on geographic proximity but also on firms' capabilities, absorptive capacity and their dynamic capabilities.

Knowledge management within the regional innovation system is crucial for innovation (Pino & Ortega, 2018). It is important to develop the competence to implement knowledge from innovations originated inside and outside the system. The innovation performance is also affected by the knowledge absorption capacity and the culture of collaborating partners. To make the ecosystem alive, a risk-taking entrepreneurial culture is essential. Another special feature is the continuous movement of ideas and people. People should be able to move easily between companies and from research institutions to business and vice versa. Interactive and dynamic firms are at the core of the regional innovation ecosystem.

An innovation ecosystem consists of a group of actors and dynamic processes that can produce solutions to different social and technological challenges. The main features of the ecosystem include top universities and research institutions, funding agencies, large established companies and new start-ups, a market for new innovative products and global networking (Oksanen & Hautamäki, 2014). Regional entrepreneurial ecosystems consist of interdependent actors located in close geographic proximity and have a shared interest. Inter firm relationships have a sense of belonging to the community and could be reflected in interdependencies between ecosystem members (Brem & Radziwon, 2017).

2.6 Triple Helix Innovation Model

Triple helix is a model for analysing innovation in a knowledge-based economy and in the model the main institutions are university, industry and government. The triple helix model of development is inherently rooted in the transition from an industrial society to a knowledge based

society (Etzkowitz & Leydesdorff, 1995). The model denotes not only the relationship of university, industry and government, but also interactions between each of these entities (Etzkowitz & Leydesdorff, 2000). There is collaborative relationship between the three major institutional spheres in which innovation policy is an outcome of interaction among those partners. Government and industry, the major institutions of industrial society, thus become part of a triad in a knowledge based economy (Leydesdorff & Etzkowitz, 1996).

The triple helix development model seeks to create robust university, industry and government interactions through the ability of individuals to circulate from one sphere to another. Interaction among these institutional spheres is the key to improving the conditions for innovation in a knowledge society (Etzkowitz & Dzisah, 2008). The model assumes a more prominent role for the university in innovation, on a par with industry and government in a knowledge based society (Etzkowitz & Klofsten, 2005). Academia plays a role as a source of firm formation and regional development in addition to its traditional role as a provider of trained persons and knowledge.

The positive triple helix narrative states that economic growth in regions can be designed and managed (Jensen & Tragardh, 2004). Industry, government and university are equal and independent partners connected to each other by a strong interest in creating economic growth. In regions with high entrepreneurial activity there is positive synergistic effects of the interactions between university and government R&D and university and industrial R&D (Kim, & Yang, 2012). This interaction will be the source of regional innovation which drives the transformation of scientific and technological development into economic outcomes.

An innovating region requires multiple knowledge bases to be able to renew itself. According to Etzkowitz (2003), industry takes on the role of production while the government is given the responsibility for overseeing the contractual relationships and policies. Universities are allocated the role of producing new knowledge and technology. The university will play a more prominent role in society through exchanging knowledge and resources with industry and government for regional economic and social development. Universities and other knowledge intensive institutions create and build up the knowledge space. Industry and business utilise this new knowledge and develop the innovation space.

Entrepreneurial university envisions an academic function that aligns economic development with research and teaching as academic missions (Etzkowitz et al., 2000). Interaction with industry practitioners exposes university researchers to a wide range of technological problems identified by industry, opening new research avenues that would not have emerged had researchers

remained within the boundaries of university research (D'Este & Patel, 2007). At the same time greater interactions with industry helps in better understanding of the application context by the university researcher.

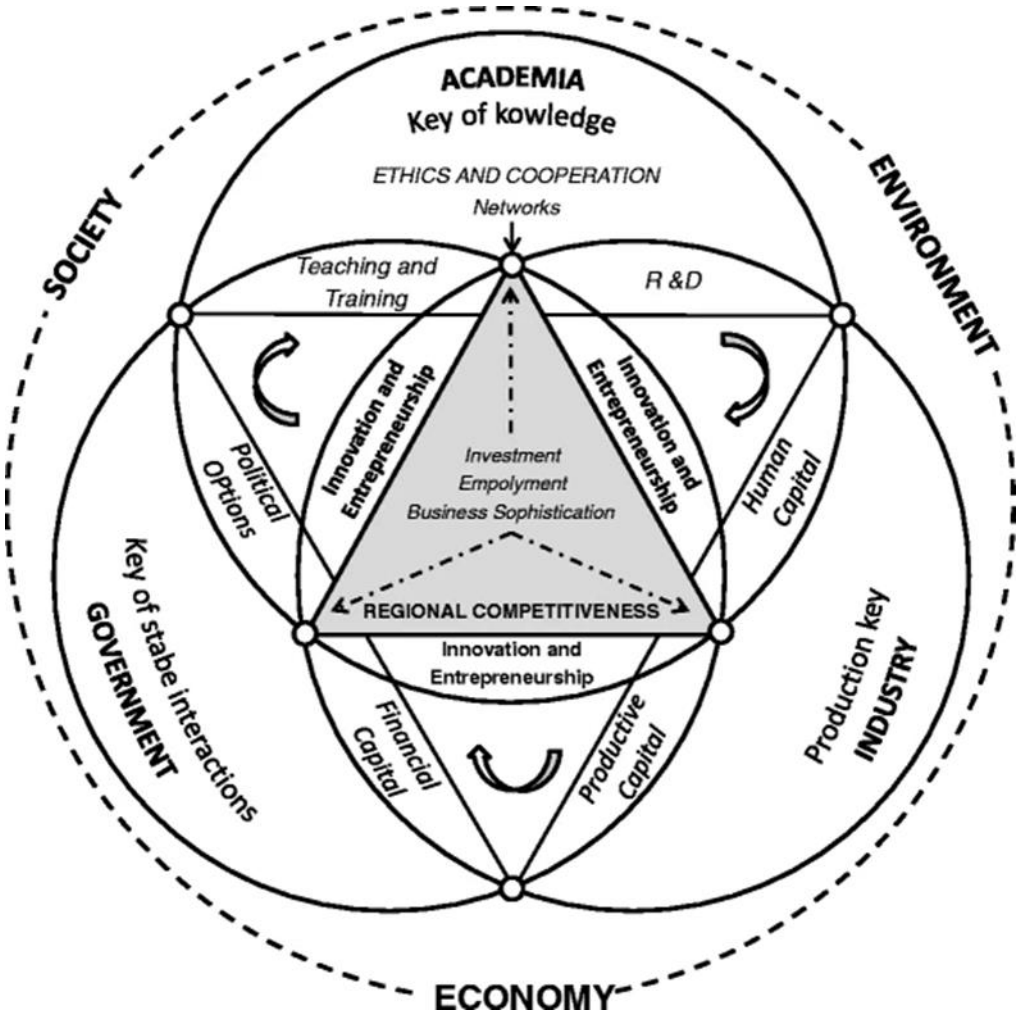

Figure 2-2 The triple helix triangulation model (Farinha & Ferreira, 2013)

The triple helix triangulation model (Farinha & Ferreira, 2013) as shown in figure 2-2 assumes innovation and entrepreneurship provide the catalysts of competitiveness and regional development. Key features of this model include cooperation between institutional spheres and businesses. This results in the creation of wealth and employment from the R&D and innovation launched by the academia and then transferred to industry with support from the government through guaranteeing of structural funds. Working with universities on research projects requires not only that firms learn to work across organisational boundaries, but also that they can build the capabilities to collaborate with partners operating within a different incentive system (Bruneel, d'Este, & Salter, 2010).

The network analysis shows that university-industry collaboration is the strongest within the triple helix in recent years followed by industry-government relations (Yoon, 2015). Those places with

entrepreneurial universities would increasingly see growing demand for knowledge transfer to industry and to society (Cooke, 2005). It is proposed that industry and government will be prepared to pay more for privileged access to knowledge-based growth opportunities by funding more research and stimulating academic entrepreneurship skills.

Despite the acknowledgement of the relevance of universities in innovation ecosystems, the understanding of how to establish and run strategic partnerships between universities and companies as well as how to manage and assess initiatives to foster companies' entrepreneurial and innovation development capacities are still open challenges (Schiuma & Carlucci, 2018). Collaborative university–industry relationships are indeed critical components of the development of an innovation ecosystem, having significant spillover effects and being positively correlated with the innovation output. Therefore, the management of partnerships with universities represents a strategic approach for developing companies' entrepreneurial and innovative capacities, which, in turn, affect the growth of an innovation ecosystem.

Inter organisational trust is the most important factor for lowering the barriers to interaction between universities and industry. Higher trust between partners stimulates interactions and encourages partners to exchange more valuable knowledge and information. Building trust between academics and industry requires long term view based on mutual understanding about different incentive systems and goals.

The strategic partnerships created within the triple helix approach are based on collaboration and cooperation mechanisms that lead to innovation (Mascarenhas, Marques, & Ferreira, 2020). The ideal triple helix scenario is that university, industry and government enter a reciprocal relationship with each other in which each of them attempts to enhance the performance of the other. The creation of new organisational schemes to promote innovation such as incubators, science parks and venture capital firms are other examples resulting from the interaction among the triple helix agents (Pique, Miralles, & Berbegal-Mirabent, 2018).

According to Ivanova and Leydesdorff (2014) the triple helix model assumes that the driving force of economic development in the post-industrial stage is the production and dissemination of socially organised knowledge. Institutions that generate knowledge increasingly play a role in the networks of relations among the key actors. The model provides us with a heuristic for studying these complex dynamics in relation to developments in the institutional networks (Leydesdorff & Meyer, 2006).

2.7 Gap in Literature

Analysing the various definitions and interpretations of the innovation ecosystem, corporate innovation, ecosystem metaphor in innovation management, the regional innovation system model and triple helix model, there are certain gaps in the literature. The current literature is not addressing the interactions which are happening within the firm and how it is being influenced by the external interactions and external environment. The regional and national innovation systems might have a real influence on the system level factors of innovation ecosystem within the firm. This internal and external interactions and how it can be synchronised to create a dynamic innovation ecosystem is lacking in the current literature.

Innovation ecosystem literature is expanding in recent years and various studies on the topic is undertaken, but mostly as part of the regional innovation ecosystem. There is a need to understand the organisational parameters which will help the firm to maximise the interactions with the regional as well as the national innovation ecosystems. The conventional methods of analysis of innovation management have to open up and adapt and be agile, which is needed with the current advances in technology and knowledge. The rigid boundaries of the ecosystem has to be replaced with a fluid interpretation of ecosystem boundaries from the firm level to regional and national level interactions. This is where the current literature is limiting, and more analysis is needed.

There is a huge gap in the current literature on New Zealand innovation environment and especially dealing with organisations within the larger innovation ecosystem. This gap is also visible on the regional level while looking at the Auckland regional innovation system. The aim of this study is to provide a new knowledge in a study involving these two areas. Hence, in the following part of this chapter a study on Auckland regional ecosystem is conducted and the next chapter is devoted to understanding the New Zealand innovation ecosystem and policies.

2.8 Auckland Regional Innovation System

Auckland is New Zealand's largest city, commercial centre and the innovation hub of New Zealand. Its economic performance has a significant impact on the economic success of New Zealand as a whole (*Auckland innovation.*2014). Auckland is a culturally diverse and young city and has the potential to grow economically provided it embrace innovation led growth and can contribute to New Zealand's innovation performance (Chen, 2012). The Auckland regional innovation system is part of a wider national innovation system in which Auckland is expected to play a major role. Activities in the Auckland region including research and development serve to support economic activity in other parts of the country.

Innovation will be critical to Auckland's future growth and prosperity. Despite its lack of specialisation, Auckland has a number of nascent clusters within key sectors including food processing and manufacturing in the south of Auckland and ICT in central Auckland and on the North Shore. Auckland essentially has all the elements of a well-functioning regional innovation system but lacks scale and international connections (Chen, 2012). It is lacking the larger high tech or knowledge intensive firms that drive private sector R&D investment in other economies.

Auckland Unlimited (formerly ATEED) objective is to help Auckland become a major innovation hub by building a culture of innovation and entrepreneurship and growing and retaining skilled talent (Auckland unlimited.2020). The Auckland Innovation Plan has been developed to capitalise on those opportunities. It has been working on improving the culture of innovation in Auckland. It seeks to increase the visibility of innovation-led entrepreneurship and encourage more people to consider entrepreneurship as a career. Its support for the development of GridAKL (Grid AKL.2016), an innovation campus, presents an opportunity to create an innovative cluster with a diverse range of stakeholders within the regional innovation ecosystem.

Technology is a key enabler of innovation, and strong tech foundations are required for sustainable innovative growth. Auckland Unlimited is working with partners to support the development of the broad ICT and technology sector and to encourage the increased use of technology in developing business solutions. The Auckland Innovation Plan (*Auckland innovation.*2014) outlines the priorities and actions to build a culture of innovation and entrepreneurship in Auckland. This plan aims to build on strong entrepreneurial foundations and develop innovation led growth as a key driver for Auckland's economic success.

The University of Auckland has responded to Auckland's development challenges by building a platform for regional innovation ecosystem in Auckland (University of Auckland innovation.2016). Along with Uniservices and through entities like Icehouse, Auckland bioengineering institute, Centre for innovation and entrepreneurship and other innovation supporting programs like Velocity and Chiasma, the University of Auckland has helped create an innovation ecosystem.

UniServices, founded in 1988 is the University of Auckland's research and technology transfer company (UniServices.2016). It also manages the University of Auckland Inventors' Fund, which is a pre-seed and seed stage investment fund for transforming university intellectual property and research into scalable global companies. Uniservices has started other initiatives such as return on science and momentum investment committees.

Return On Science connects science and technology entrepreneurs with advice and guidance, management support and efficient access to capital (Return on science.2016). It is a national research commercialisation programme that leads to deliver new research to market from universities, research institutions and private companies. Four specialist investment committees give projects the domain specific experience and connections from across the spectrum. These are Agritech & Foodtech, Biotech & Life Sciences, Digital Technologies and Physical Sciences. In addition to valuable advice, the investment committees can provide access to capital needed to progress a project.

The Momentum programme (Momentum.2016) is comprised of a number of student-led investment committees. These committees have a focus on start-up ventures, particularly those originating from tertiary student and staff owned intellectual property and technologies. Momentum investment committees provide presenting teams with advice, support and investment. Teams comprised of students and staff of either tertiary education institutes or Crown Research Institutes are able to access these investment committees without charge. Private companies are also able to utilise the expertise of these investment committees for a nominal fee. Momentum is now a national programme in its own right and is seeking to form new investment committees across New Zealand.

The Auckland Bioengineering Institute (ABI) is a research institute at the University of Auckland with around 150 full time staff and 100 graduate students (Abi.2014). The ABI is leading the international Physiome Project (Iups.2014), which aims to understand the human body with anatomically and physiologically based mathematical models. Most of the institute's work over the last 20 years has focussed on particular organs or organ systems. On the basis of the ABI's modelling and instrumentation work and through collaboration with Callaghan Innovation, has created a New Zealand Consortium for Medical Device Technologies (CMDT) and subsequently established the Medical Technologies Centre of Research Excellence (MedTech CoRE) in New Zealand. ABI also runs an incubator space called Cloud 9 to nurture fledgling spin-out companies to work closely with their research groups and continue their R&D.

In 2009 the University of Auckland Business School formally established a Centre for Innovation and Entrepreneurship to create the infrastructure to grow entrepreneurial education at the University of Auckland (Cie.2014). The mission is to unleash the spirit of innovation and entrepreneurship at the University of Auckland. The various activities include experiential programmes, events, workshops, access to funding, mentors, maker space and the opportunities to connect with

likeminded peers. The goal by 2025 is to have 10 percent of all students from the university leave with a meaningful entrepreneurship experience.

Velocity is a highly successful entrepreneurial development programme and business planning competition that students at the University of Auckland are empowered to run. The programme (formerly Spark) has attracted more than 15,000 students since 2003 (Velocity.2014). Ventures started by alumni through Velocity have raised over $258 million in capital. Spark was born out of an idea to transform New Zealand into a growing and prosperous nation by reshaping its economy. Modelled on programmes operating in highly effective hubs of innovation, Velocity has been successful in creating graduates filled with a spirit of innovation and a culture of entrepreneurship. Situated in the Unleash Space innovation hub, the VentureLab incubator, launched by the Centre for Innovation and Entrepreneurship (CIE) in 2018, gives the winners of 'Velocity challenge' competition the space, expertise and resources to fully develop their ideas (Venture lab.2020).

Chiasma is a national organisation that creates links between academia and the wider science, technology, engineering and mathematics (STEM) industries. The mission is to inspire and help members to develop a successful career in the STEM industry by providing them with the necessary skills, networks and mindset (Chiasma.2016). Chiasma has grown into a successful student led organisation, with branches in Auckland, Wellington, Christchurch and Dunedin and with over 3500 student and industry members. Each centre runs their own networking events, workshops, discussions and mentorship programmes tailored towards the students and industry.

The Newmarket Innovation Precinct (NIP) connects industry professionals with the University of Auckland's research and technical experts (Nip.2020). The NIP is a multidisciplinary, industry-facing R&D community, based at the faculty of engineering at the university. The aim is to connect companies facing technical challenges with experts who are committed to having real world impact.

AUT Ventures Limited is the commercialisation arm of Auckland University of Technology (AUT ventures.2014). It is a fully owned subsidiary of AUT with a board of directors responsible for administering the equity portfolio resulting from AUT's commercialisation activity as well as evaluating larger commercial projects. As the commercialisation arm of the university, they provide access to AUT's intellectual property portfolio, research consultants, commercial research and investment opportunities.

Massey University's E-Centre connects entrepreneurs with investors, mentors, academics, researchers and with the alumni network (Massey E-center.2020). The centre has the capacity to connect students with some of the best minds in New Zealand and also provide the opportunity to

apply for funding. The goal is to generate an entrepreneurial spirit in the Massey university student community that will feed into the resources and talents of the wider community and regional innovation ecosystem.

GridAKL is an innovation campus based in Auckland's Wynyard Quarter which is designed to encourage collaboration. Opened in May 2014, the GridAKL innovation precinct brings more than 70 technology companies together (Grid AKL.2016). This campus facility is for anyone involved in innovation which includes start-ups, national and multinational companies, research institutes and other ecosystem partners. These are supported by a network of investors, education providers, government agencies and other key partners in the New Zealand's innovation ecosystem.

Icehouse is an Auckland based incubator which has grown to become a major player in the regional as well as national innovation ecosystem. The aim of Icehouse is to grow a community of entrepreneurs and business owners which can accelerate the progress of New Zealand in becoming a thriving economy (Icehouse.2020). The focus is to establish and maintain a growth mindset in New Zealand businesses and to fulfil their potential. The Ice Angels network, an angel investment arm which is part of Icehouse, has grown to over 200 members. Icehouse has over 850 individual investors and have $123 million invested in NZ start-ups (Icehouse.2020).

Outset ventures (formerly Level Two) is an Auckland based incubator which aims to grow Deep Tech start-ups from early stage to a stage where the firm has a global Impact (Outset ventures.2020). Deep tech innovations are disruptive solutions built around technology and scientific advances. Level Two alumni include two unicorn companies such as Rocket Lab and Lanzatech. It has created over $1 billion in economic growth for New Zealand and over three hundred patents are held by Level Two companies (Outset ventures.2020).

Callaghan Innovation is named after the late Sir Paul Callaghan, who championed the role science could play in making New Zealand an economic success (Callaghan.2020). It is one of the Government's key entity for the commercialisation of science, engineering, technology and design (MBIE, 2020a). It has objectives to accelerate the growth, scale, intensity and success of innovation in New Zealand and to increase the drive among firms to invest in R&D and support export growth.

Callaghan Innovation was established in 2013 to partner with businesses to help them become more innovative and to enhance the operation of New Zealand's innovation ecosystem. It works closely with government, crown research institutes, universities and other organisations to help increase business investment in R&D and innovation. It provides R&D grants and help in developing new products through assistance with R&D that firms themselves would struggle to achieve. It can

also help build a firm's capability to innovate and its commitment to R&D. The purpose is to create and deliver innovative products and services that enable businesses to be competitive in the global market.

New Zealand Trade and Enterprise (NZTE) is the Government's international business development agency with 46 offices worldwide (Nzte.2020a). Its primary function is to work with New Zealand companies to grow their exports. NZTE's capital team helps investors find and capitalise on investment opportunities in New Zealand. They have a dual focus of growing export companies out of New Zealand and attracting investment into New Zealand.

The New Zealand Growth Capital Partners (formerly New Zealand Venture Investment Fund) was established to support early stage technology companies and to stimulate private investment (Nzgcp.2020). The NZGCP was established by the New Zealand Government in 2002 to build a vibrant early stage investment market in New Zealand. They currently have two investment vehicles called the Aspire Fund and Elevate Fund. Aspire Fund partner with other private investors to make direct investments into early stage companies. Elevate Fund is a $300 million fund program that looks to fill the capital gap for high growth New Zealand businesses at the Series A and B fund raising stage.

Advantages for the Auckland region include its role as an international gateway, commercial hub, quality of education and research institutions, cultural diversity and high quality of life (Martin Jenkins, 2011). Competitive disadvantages for the region include weaknesses in the innovation system, infrastructure constraints, expensive housing, large distance from major markets and relatively small population base. Auckland is a moderate performer in terms of innovation. There are weaknesses in Auckland's regional innovation system ranging from ineffective mechanisms for commercialising research and a lack of key supports such as industry-based science and business parks.

Auckland is an attractive destination for foreign direct investment but for investments related to sales and marketing rather than value added activities such as R&D (Ministry of Economic Development, 2011). Auckland scored lower than other global cities in terms of entrepreneur's intentions to grow their business beyond 10 employees. This indicates a need to look at business aspirations and intentions as a contributing factor to entrepreneurship. There is initiative to establish businesses of a small size, but barriers exist to their expansion. These barriers may be related to cultural and lifestyle considerations as well as market characteristics.

Auckland's research organisations including universities and crown research institutes make significant investments in R&D. But compared with other international city regions the percentage spend in R&D is lower in Auckland. The lack of connectedness between firms and research organisations is the greatest weakness in the regional innovation system. Auckland firms perceived difficulties engaging with research institutes, universities and other research providers (Chen, 2012). The lack of public and private sector collaboration among universities, research institutes and industry need to be addressed. Auckland regional innovation ecosystem also shows a lack of strong management capability and commercialisation skills.

Auckland competes with other city regions for skilled migrants and it needs to ensure that the skills of migrants are well utilised. There have been concerns expressed over several years that, although the majority of migrants settle in Auckland, many do not settle well (Chen, 2012). Relative to other global cities, the cost of living in Auckland is high compared to the income levels. Immigration policy and immigrant support system should be reviewed to ensure that those with key skills can enter the Auckland regional ecosystem and that those skills can be effectively utilised for innovation and economic growth.

Auckland's future prosperity depends on the performance of its businesses and the region's ability to compete internationally for investment and skills. People are attracted to more productive economies with better business opportunities, living standards and higher wages. Improving collaboration across the ecosystem will foster more higher value innovation and high growth potential ventures (ATEED, 2019). A key economic challenge facing Auckland is to successfully transition from a development model based on working more hours per capita to one that is focused on generating more value from time spent at work. This requires transitioning to an economy led by innovation with high value products and services and better international connection. Enhancing the economic performance of Auckland will depend on improving productivity through a focus on advanced industries, skills, innovation and high value exports (Auckland unlimited.2020).

2.9 Summary

The literature review on corporate innovation, ecosystem thinking in innovation research and implications of using the ecosystem metaphor for the study of innovation is done. It also looks at the possibilities of using the ecosystem metaphor and its importance in the recent literature on innovation. Innovation ecosystems are dynamic structures, and they evolve according to changing conditions. It is possible to initiate and manage ecosystems through conscious interventions and is

important to consider the system view of firm level innovation and also to look at the big picture of regional effects. This will help to develop a holistic understanding of the challenges for the creation of a vibrant ecosystem for innovation.

Regional innovation ecosystem needs systems and processes to engage people, define shared purpose and create conditions for good collaboration. The innovation performance of the region is affected by the knowledge absorption capacity, dynamic capabilities and the social and traditional culture of collaborating partners. Cultural norms and trust that reward entrepreneurial action will enhance cooperation between the regional actors. Under the triple helix framework, industry, government and university are equal and independent partners connected to each other by a strong interest in creating economic growth.

Auckland regional innovation system have a sufficient base of people and an institutional framework on which a vibrant innovation system can be built. But there are challenges in parts of the innovation system with the innovation actors and the lack of linkages between them. Auckland is a moderate performer in terms of innovation. Cultural and lifestyle considerations as well as market characteristics are responsible for businesses maintaining a very small size and low scale development. More capital investment, better immigration policy to bring high skilled individuals, having high value-added industries and more international linkages are essential for creating a vibrant regional innovation ecosystem.

The current gap in the literature is analysed and it is decided to focus on the internal and external interactions between the organisational level factors and the regional and national level innovation ecosystem. The following chapter will look at the New Zealand innovation system and the policies along with barriers and opportunities for the country. This is an attempt to look at innovation from a holistic perspective in relation to New Zealand and the firms in that system.

3.0 Country perspective: New Zealand research and innovation policies

3.1 Introduction

This chapter is looking at the macro level of New Zealand innovation ecosystem and policies which are relevant for making the right incentives for interactions between the various actors in the ecosystem. The country was an economic powerhouse in the early 20th century but started to lag behind other OECD countries since the 1970's. There are multiple reasons including policy decisions which were responsible for the downfall. A look at the macro level innovation ecosystem gives a system view on the interactions between organisational level innovation ecosystem and the national level.

3.2 New Zealand innovation ecosystem

> "Ranked number one in three important growth fundamentals categories reported by the World Economic Forum, including ease of setting-up businesses, investor protection and lowest trade barriers, New Zealand is an average performer when it comes to economic growth, productivity and innovation"
>
> (Hong et al., 2016).

Until 1972 New Zealand was one of the richest societies in the world and at that time country's real GDP per capita was approximately 15 percent higher than the OECD average (ERA, 2012). But today New Zealand is a country whose relative income has declined and whose overall growth has been surpassed by other developed countries (Frederick, Thompson, & Mellalieu, 2004). According to Conway (Conway, 2018), GDP per capita in New Zealand in 1950 was around 125 per cent of the OECD average. By 1980 GDP per capita had fallen to around 90 per cent of the OECD average and is around that figure ever since. Trade as a percentage of GDP stands at a low 56% which is too low for a small economy.

In spite of a macroeconomic and institutional framework which should be ideal for promoting innovation the innovation performance of New Zealand is poor (Hong et al., 2016). This is also known as the 'New Zealand paradox'. The weaker innovation performance may be attributed to the size of firms, the size of local markets and the size of cities in New Zealand (OECD, 2019a). New Zealanders work harder and earn less than most other people in the developed world according to

Shaun Hendy and Paul Callaghan in their book 'Get off the grass'(Hendy, 2013). There are various other studies and reports which substantiate this fact. A study of the country factors and especially the cultural and collaboration factors is to be done in order to find the effect this has on the innovation ecosystem at the regional as well as at the organisational level.

> "Despite generally good macroeconomic and structural policy settings, New Zealand has relatively low productivity levels and hence earnings. This is due to lack of international connection and scale, qualification and skills mismatches, weak competitive pressures and low rates of capital investment and R&D activity. Relatively low productivity depresses well-being by holding down earnings and household incomes and revenue available to fund societal goals. New Zealand's location and small population are contributing factors as they constrain gains from specialisation and agglomeration." OECD Country Report on New Zealand (OECD, 2019a).

New Zealand has been working harder rather than smarter (New Zealand Productivity Commission, 2021). The productivity commission report shows that New Zealand's innovation ecosystem is not currently working well for actual and potential frontier firms and it is weaker on most dimensions when compared with other small advanced economies. New Zealand's most productive or "frontier firms" have productivity levels only about half of what they found in other small advanced economies. Few New Zealand businesses export at scale without natural resources as their base. In the last 10 years, New Zealand's ranking in the Economic Complexity Index (ECI) fell due to a lack of diversification of exports into areas where it has a sustained competitive advantage.

According to the OECD (2020), low R&D investment and innovation rates appear to be important factors behind New Zealand's low economic productivity. A comparison of GDP per capita versus national R&D expenditure per capita for countries confirms that increased investment in R&D correlate to increased GDP (Raine, O'Reilly, & Teicher, 2011). There are various studies and observations which show that New Zealand has been less successful in converting the research into products or services. New Zealand universities and public research centres file fewer patents as a proportion of GDP than their counterparts in other OECD countries (MBIE, 2019d). Academic-business collaboration remains relatively low, with only 1.5 percent of publications having

academic-business co-authorship and 4.6 percent of higher education research funded by business in 2016 (MBIE, 2018).

The level of patent activity is relatively low in NZ, with only 11.8 patents per million population compared to countries like Denmark and Finland with 60.1 and 60.6 patents per million respectively (OECD, 2020). New Zealand's production of triadic patent families is significantly lower than countries such as Switzerland, Finland and Denmark (MBIE, 2019d). This is partly because of the nature and size of the firms involved in R&D activity in New Zealand. Another important factor is the heavy reliance on primary and low-tech industries.

The key challenge facing the research, science and innovation system is building stronger connections within the system and beyond. Many Kiwi researchers, institutions and innovators are focused on New Zealand as their frame of reference (MBIE, 2019d). As a result, they may fail to make connections with global experts or position their products to major markets. New Zealand researchers also appear less well connected with potential users of their research. Access to knowledge for the industry sector and mobility of staff between the research sector and industry are limited. This is shown in figure 3-1 in which New Zealand RSI system is compared with OECD countries as well as small advanced economies. The country's ranking in business funding of higher education as well as international firms which are born out of New Zealand is abysmally low.

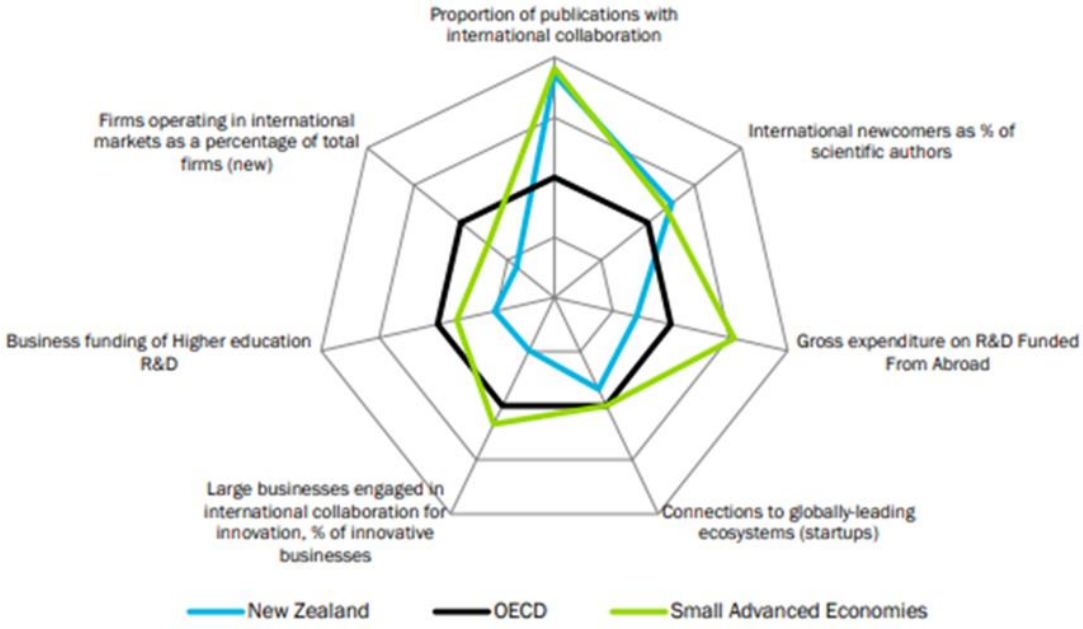

Figure 3-1 New Zealand Research, Science and Innovation System (MBIE, 2019d)

There is also evidence that the participants in the New Zealand innovation system are not very well connected among themselves. New Zealand founders score poorly relative to founders in other

ecosystems in terms of the number of quality relationships they have with other founders, investors and experts (MBIE, 2019d). Kiwis' "number 8 wire" approach to life indicates that individualism and do it yourself mentality creates barriers to seeking advice that would improve innovation capability. These barriers tend to affect the innovation system capability and long term strategic direction (Raine et al., 2011). Weak connections hinder sharing of knowledge and reduce the flow of capital to support the development of innovations within New Zealand.

Lack of engagement between business and research organisations is the primary barrier in creating a knowledge economy (Raine et al., 2011). Many businesses are unfamiliar with what knowledge and expertise resides in research organisations or is under development. Business reported that much of the research conducted in research organisations is based on what is academically interesting to the researchers rather than what business and industry requires. The lack of mobility of R&D staff between universities, research institutes and industry also contribute to lower levels of knowledge spillover.

Wakeman and Le (2015) suggest that although New Zealand may be quite productive in generating scientific publications it does not necessarily flow through to downstream innovation. New Zealand fares poorly in converting inputs into outputs like knowledge flows, commercialisation and entrepreneurship. Study findings suggest that the complementary capabilities necessary to take innovations to market and capture value from innovation are less available in New Zealand compared to other OECD countries. Clusters of innovative firms are too small to generate the types of knowledge spillovers that are the key drivers of growth in Europe, Asia or the USA.

Recognition of the lack of scale indicates a clear need for greater networking and collaboration between ecosystem partners and for greater sharing of knowledge to drive effectiveness and efficiency of research. While the overall level of investment in the science and innovation system is too low, under investment by the private sector is the most significant barrier to innovation led economic growth (Raine et al., 2011). New Zealand firms' attitude towards risk, focus on short term gains rather than long term benefit and conservative corporate management are barriers to innovation. The majority of firms are less willing to undertake risk and they will only fund innovation using cash flow or retained earnings (Hong et al., 2016).

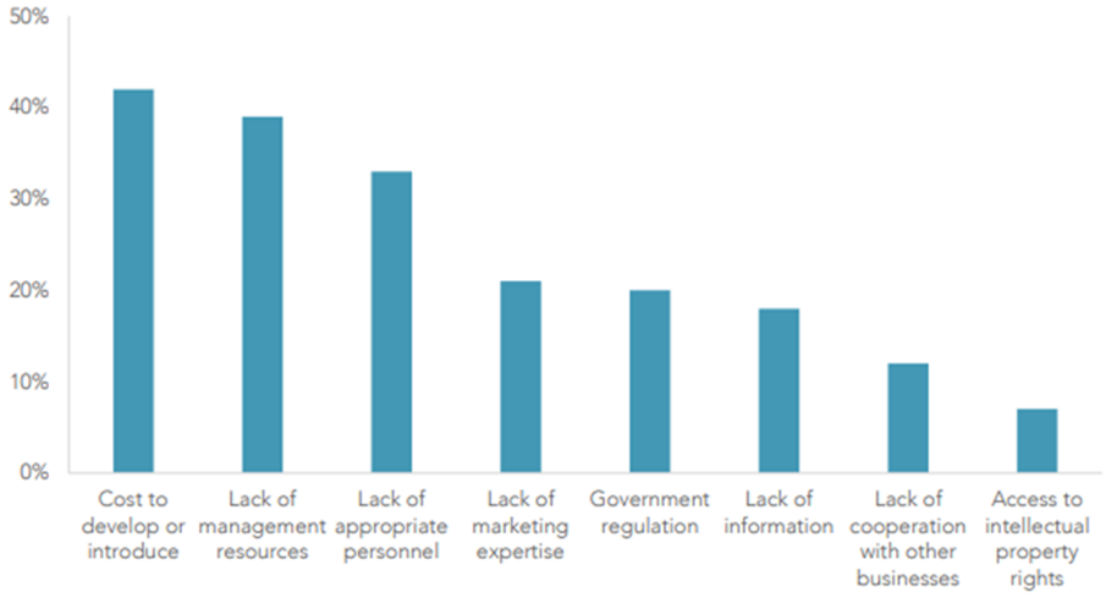

Figure 3-2 Barriers to innovation in New Zealand ecosystem (Stats, 2019a)

The main barriers to innovation in New Zealand are shown in figure 3-2. New Zealand is sometimes described as a trading nation, but the reality is that only a small number of firms are internationally engaged at scale (Skilling, 2020). There is not a culture of building global companies from New Zealand to scale. Private sector behaviours, management capability and aspiration level along with weak incentives to expand are some of the barriers facing firms. New Zealand has not made significant investment in skills and innovation and has not focused on developing knowledge intensive competitive advantage.

New Zealanders are associated with the ability of spotting opportunities yet rank lower when it comes to the exploitation of such opportunities, according to Maritz and Beaver (2011). MBIE has cited lack of time, money and employees with the right skillsets as the main constraints to innovation and R&D (MBIE, 2019a). The reason businesses do not innovate appears to be because they consider they have little need to do so since they face less competition. Businesses believe that government can do more to support innovation. They suggest that government should improve the skills system to better meet industry's needs and provide more information about government's direction and strategies.

Hong (2013) argues that the small size of firms, the small size of the market and the level of geographical isolation explain New Zealand's relatively poor performance in innovation. Most firm level innovations are incremental improvements with low investment commitments and faster return. Most radical innovations are sold to multinationals for future development and commercialisation. New Zealand manufacturers have traditionally not been great collaborators

except at a transactional level (Hong et al., 2016). A smaller proportion of businesses in New Zealand collaborate on innovation compared to other economies. Even among large firms the proportional engagement in international collaboration for innovation is much lower than the OECD and SAE average.

Shangqin, McCann and Oxley (2013) suggest that in a small and isolated country like New Zealand small firm size may not be an advantage for innovation. The reason appears to be that the notion of 'small' itself may have an absolute minimum threshold, below which translating entrepreneurship into innovation doesn't happen. New Zealand's scale and geography may be disadvantageous in terms of translating entrepreneurship into innovation. Being a small firm in New Zealand implies being a micro or a nano-firm in many other countries and they are too small to maintain the levels of R&D required in order to come up with continuous innovations (Skilling, 2020).

Figure 3-3 Portfolio of firms in New Zealand ecosystem (Nzte.2020b)

New Zealand's economy is comprised of around 12,000 companies that export goods and services around the world. Most of these companies earn less than $5 million a year in revenue as shown in figure 3-3. Around 300 companies earn more than $25 million per year and it is those companies that contribute most of the export earnings (Nzte.2020b). New Zealand's export share of GDP has not changed meaningfully over the past few decades and is at the same level as it was in the early 1980s (Skilling, 2020). Out of New Zealand's $86 billion in exports in the year 2019 around $32.5 billion came from dairy, red meat, forestry and fruit. Tourism is another major component and the third major component is tech exports.

For the business sector in 2019, R&D expenditure reached $2.4 billon, twice that spent in 2012 (Stats, 2019b). Services businesses make up two-thirds of the total New Zealand economy and account for a wide range of industries including construction, wholesale trade, ICT, and healthcare. There is evidence that the New Zealand high value manufacturing and services sector is underdeveloped and could contribute substantially more to the economy (Raine et al., 2011). Tech industry is New Zealand's third-biggest export sector, bringing in more than $16 billion a year in overall revenue (Callaghan Innovation, 2017). New Zealand's 200 largest tech exporting companies by revenue have exceeded $12 billion in total revenue and $9.4 billion in export earnings according to Technology Innovation Network report (TIN, 2020).

Gross domestic spending on R&D is defined as the total expenditure on R&D carried out by all resident companies, research institutes, university and government laboratories etc., in a country. Gross domestic spending on R&D for NZ is 1.4 percent of GDP compared with the OECD average of 2.4 percent (OECD, 2020). R&D expenditure by businesses accounted for 55 percent of total R&D expenditure. New Zealand has around 20,000 full-time equivalent (FTE) researchers, around 4,000 R&D performing businesses, eight Universities, seven Crown Research Institutes (CRIs) and many independent research organisations, business accelerators and incubators, and other support functions (MBIE, 2019d). Overall investment in this system was just under $4 billion in 2018, with government investment accounting for around 45 per cent of this. The NZ government has set a goal to raise R&D expenditure to 2 percent of GDP by 2027 (MBIE, 2019d).

Much of New Zealand's GDP growth over the past 30 years has come from growth in hours worked with low labour productivity growth rates (Skilling, 2020). New Zealand firms have expanded through labour rather than through capital and technology. New Zealand businesses are typically capital deficient, and this has lowered labour productivity (New Zealand Productivity Commission, 2021). Comparison of New Zealand with other major industrial countries are shown in figure 3-4 which clearly shows lack of investment in capital. There is significantly less incentive to invest in capital or innovation in the domestic sectors because of the scale and the lack of competitive intensity. Few large firms face competitive pressure to invest heavily in research, new technology, or expansion into international markets. A common factor across large firms in New Zealand is a reluctance to provide capital for growth and a strong aversion to risk, especially associated with expansion into overseas markets (Conway, 2018).

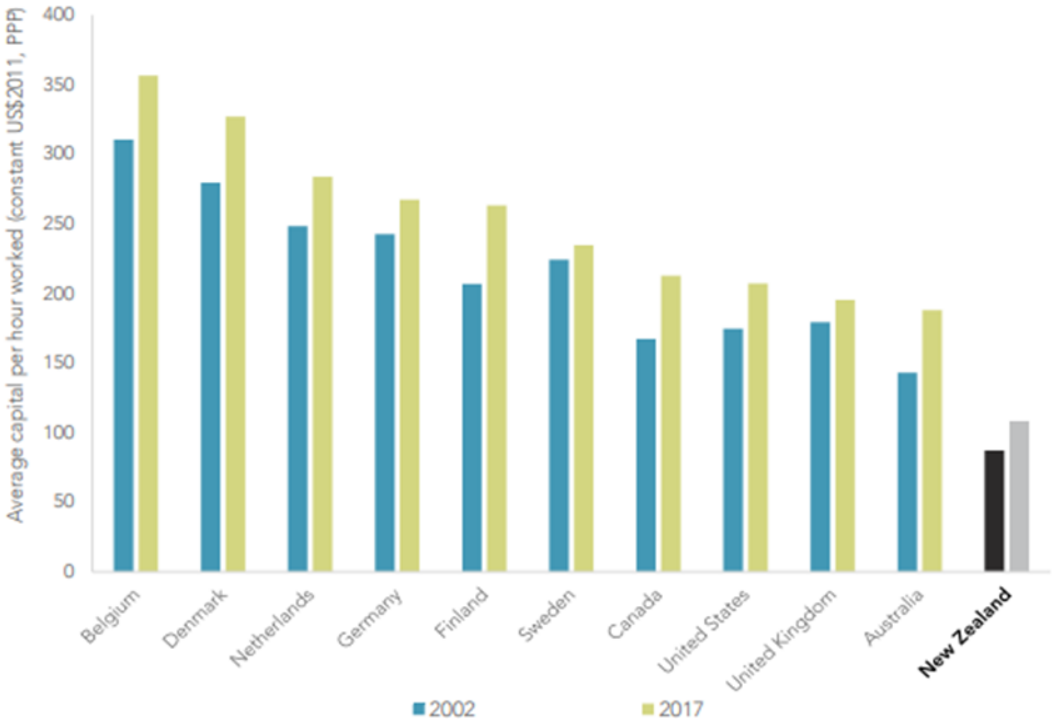

Figure 3-4 Capital intensity of different countries (New Zealand Productivity Commission, 2021)

New Zealand has an undernourished innovation ecosystem (Hendy, 2013). By focussing on fully appropriable R&D, firms minimise the knowledge spillovers that would enhance the competitiveness of other firms in the ecosystem. This negatively impacts the development of a more robust innovation ecosystem. Lack of collaboration and very low patent co-ownership by New Zealand firms and research organisations are visible proof of an ecosystem which favours closed innovation. Coexistence of high and low productivity firms may point to weak knowledge diffusion within the domestic economy (Conway, 2018). Possible reasons for weak knowledge diffusion and productivity includes structural factors, such as weak international connection and the geographic segmentation of domestic markets.

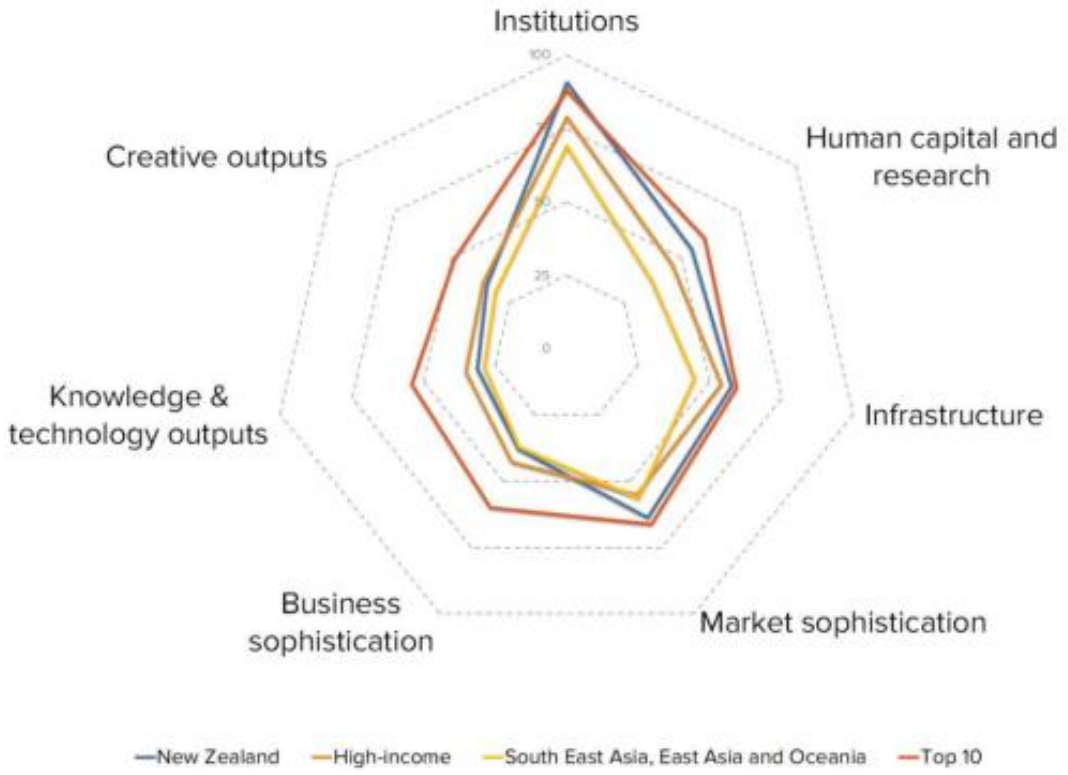

Figure 3-5 Benchmarking New Zealand against other economies.

New Zealand has high scores in four out of the seven Global innovation index (GII) pillars and scores below average for its income group in three GII pillars: business sophistication, knowledge & technology outputs and creative outputs as shown in figure 3-5. New Zealand performs best in institutions and its weakest performance is in knowledge & technology outputs. It also produces less innovation outputs relative to its level of innovation investments (GII, 2020).

A characteristic of the New Zealand science and technology research and innovation system is that resources are scattered throughout the country and individual institutions lack critical mass in research impact. This is shown in figure 3-6 which clearly shows how siloed various initiatives are. For a small country like New Zealand, it is hard to afford such luxury and the lack of a focussed approach.

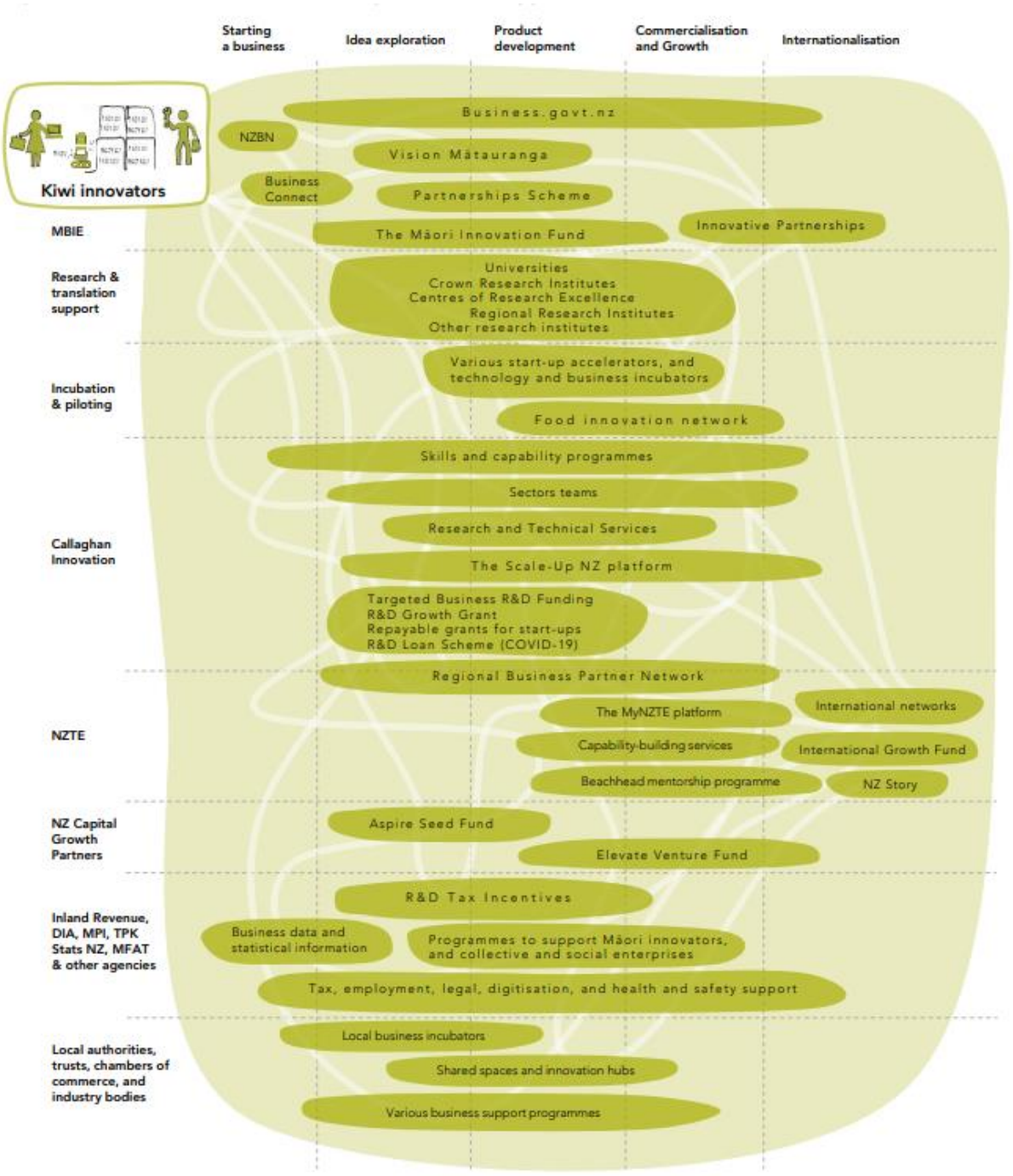

Figure 3-6 Firms' interactions with government support for innovation (New Zealand Productivity Commission, 2021)

There are lots of government supports for innovation, but it is siloed, fragmented and confusing. Focused effort is missing and hence the impact of output is not substantial (New Zealand Productivity Commission, 2021). The evidence shows that New Zealand's innovation ecosystems is unable to propel firms into exporting at scale in areas of competitive advantage. New Zealand has fewer technology start-ups per head of population than other small advanced economies and the OECD (MBIE, 2019d). It also has a lower proportion of innovative firms than the OECD and SAE average. There is a huge need to grow the number of start-ups and scale them up by ensuring the

support they need at each stage in their life journey. For a small economy like New Zealand international connection is the only way of securing the benefits that come with large markets. New Zealand innovation ecosystem entities are working within their silos so that collaboration is less and synergy rarely visible.

The current New Zealand innovation ecosystem is fragmented, resulting in a reactive rather than strategic investment in the country's future (Callaghan Innovation, 2018). As a small country the approach to try and compete in a wide variety of sectors is not sustainable. New Zealand innovation ecosystem partners are working within their silos and sub optimising their initiatives which prevents fruitful collaborations and formation of any synergy between them. Finding of new markets for its primary produce has slowed New Zealand economic diversity since there was less incentive to innovate and diversify its export market. Domestic investments in housing and tourism is diverting capital to less productive sectors. Innovation, knowledge and R&D leadership is lacking from both government and private sector.

New Zealand's economic performance needs a step change improvement. It's GDP per capita is 30 percent less than Australia and 16 percent less than the OECD average (Boven, 2009). For most OECD countries, the main export group is machinery and transport equipment, followed by chemical products, food and drink, crude materials and mineral fuels. In contrast, New Zealand's most developed industries are focused on tourism and exports of agricultural products and are the main source of growth (New Zealand GDP growth rate.2020).

Despite generally good macroeconomic and structural policy settings, New Zealand has relatively low productivity levels and hence earnings (OECD, 2019a). Addressing inequalities and better understanding the requirements for sustainable development will be important for New Zealand's well-being over time. More collaboration and knowledge sharing have to happen so that there is a collective effort to improve the innovation scenario and to enable firms to scale up and grow.

3.3 Examples of successful innovation ecosystems

For ecosystems to be innovative there must be a constant and balanced cross pollination of ideas, knowledge and technology between the partner elements (Estrin, 2009). Understanding the factors behind the success of certain cities and regions within their regional eco systems will enable us to extrapolate and use this knowledge in other regions. Sharing knowledge about successful practices supports collaborative learning and stimulates good practice everywhere. Understanding the importance of innovation, entrepreneurship and collaboration is essential to the future success of

cities and regions. Here we look at some successful innovation eco systems within their country perspective.

3.3.1 Finland

Finland has transformed itself from an agricultural into an industrial economy and then quite rapidly into one of the leading countries of the knowledge economy (Sotarauta & Kautonen, 2007). The policy of innovation systems and cluster approaches worked relatively well in making Finland one of the most innovative countries in Europe. The national innovation system emphasised on the creation and utilisation of knowledge and education and the ability to collaborate both nationally and internationally. According to Makkonen and Inkinen, Finland was one of the first countries to incorporate the national innovation system concept into its science and technology policy (Makkonen & Inkinen, 2014). The early adoption of innovation system policy paved the way for the rapid advance of innovation and economy in Finland. Soursa (2007) argues that the economic success of Finland is remarkable considering the fact that it has no natural resources besides wood and has not had any large internationally active firms before Nokia.

> "Supported by continued investment in education, research and innovation, Finland achieved a widely acclaimed transition from a largely resource-based to a leading knowledge-based economy shifting towards high-technology manufacturing and knowledge-based services." (OECD, 2017)

In Finland, the growth of the economy takes place in three areas: in the Helsinki area, where most of the people live, in the Tampere region in central Finland and in the Oulu region in the north (Smedlund, 2006). Helsinki with a high-level of the talented and educated workforce and strong international ties has shaped a thriving innovation economy (Esmaeilpoorarabi, Yigitcanlar, & Guaralda, 2018). One of the most characteristic means of implementing innovation in the Helsinki region is the 'living lab' network which was set up in 2007 to meet the challenges of product development (Anttiroiko, 2016). It provides a platform that aims at promoting user driven innovation and tools for improving the real-world development of products and services.

Finland is ranked among the key global innovation leaders and the Helsinki Region is the centre of country's economic activity (Saarnivaara, Halme, & Mitchell, 2018). Skilled people, the quality of research and education environment and business landscape makes this region strong in terms of innovation. The region has transformed itself into a successful innovation ecosystem with several

locally based ecosystems collaborating effectively. The city has developed into a leading global innovation hub where ecosystem thinking is fully integrated in practice and where entrepreneurial discovery and a start-up mentality drive collaboration.

Finland has for many decades had strong institutions and substantial government funding to foster collaborative research between public agencies and the private sector in significant areas of the economy. Research and Innovation Council, headed by the Prime Minister is formed to bring together government leaders, industry experts and researchers to prioritise areas of the economy and technologies for concerted effort. National innovation surveys indicate that industry-university collaboration in research in Finland is among the highest in OECD countries.

Finland has a robust school system, technology and innovation policies and regional development programmes dealing with innovations (Jauhiainen, 2006). The Finnish innovation system has evolved as a result of the interactions between firms, universities and research institutes in R&D activities (Oinas, 2005). The country has a small population with relatively tight social networks and cross sectoral linkages which helps with collaboration between different parts of the innovation ecosystem. Finland is interesting as a benchmark case for analysing the process of technology innovation (Simonen & McCann, 2008). It is one of the world's most specialised countries in terms of high technology outputs with one of the highest national R&D to GDP ratios.

Finnish R&D expenditures relative to the GDP has been among highest in the world (Boschma & Sotarauta, 2007). The high R&D intensity in Finland is largely based on the private sector's R&D investments. The general trend in R&D specialisation has been towards high-tech industries. Technology Industries are responsible for half of Finnish exports, 75 percent of private sector R&D and over 31 percent of employment (Finland Statistics, 2020).

Success factors for Finland include major investment in R&D, the large number of R&D employees, the specialisation of the economy in knowledge intensive growth areas, a strong culture of cooperation, a world-class school system, high quality healthcare system, the consideration of the environmental perspective in decision making and cohesive business environments (Boschma & Sotarauta, 2007). Finland shows a way to strengthen the participation of SMEs in innovation through the promotion of innovation linkages between large firms and SMEs. One funding criterion for large companies is research co-operation with other innovation actors including SMEs, research organisations and universities.

Finland is a small export intensive economy with a well-coordinated and active innovation policy. It provides an example of an economy where the diffusion of information and communication

technologies is high. The country was able to have a rapid technological development based on constantly increasing specialisation and raising levels of education. The relationship between skills, innovation and economic outcomes is more crucial for small advanced economies given their deep exposure to the global economy. Finland is a classic example of a small economy that deliberately invested in skills and innovation from the early 1990s to develop new sources of competitive advantage (Finland, 2011).

3.3.2 Silicon Valley, USA

Silicon Valley is a global hub of entrepreneurship and innovation in a range of industries including software, information technology, internet, social media and biotechnology (Stephens et al., 2019). The region is a highly concentrated cluster of technology firms, education and research institutions, funding agencies and all other elements responsible for a successful innovation ecosystem.

The supply of highly skilled workers along with Stanford and Berkeley trained scientists and engineers has given the resource advantage to Silicon Valley (Bresnahan, Gambardella, & Saxenian, 2001). The region attracted engineers from all over the United States and from around the world. In the 1950s, rapid growth in the semiconductor industry started in Silicon Valley with Shockley Semiconductor Laboratories (Stephens et al., 2019). The invention of microprocessors at Intel in 1971 paved the way for the next technological wave in personal computers. The next wave of firms was based on the internet and information technology and the wave continues with social media, driverless cars and cloud technologies.

There are various studies done on the success of Silicon Valley as a successful innovation ecosystem. The various characteristics that shaped the valley include the decentralised structure and engineering driven specialised nature of the organisations (Blank, 2010). The key to their success has to do with collaboration, knowledge spillover and a culture of innovation which makes them adaptable, nimble and flexible. According to Saxenian (1994), Silicon Valley has a regional network-based industrial system that promotes learning and mutual knowledge sharing among firms. The region's dense social networks and open labour markets encourage entrepreneurship and experimentation. Companies compete intensely and at the same time collaborate with each other.

Silicon Valley is the ecosystem with the highest start-up density worldwide (Schuh & Woelk, 2017). It captures more venture capital investments and start-up exit values as the rest of the top 20 ecosystems combined. About half of all start-up employees have previously worked in another start-up. Therefore, a broad experience of lessons learned in high tech entrepreneurship exist in Silicon Valley. Due to unrestricted knowledge exchange and the presence of new scientists and

young entrepreneurs from nearby universities like Stanford and Berkley, a constantly evolving innovation ecosystem has emerged in Silicon Valley. Stanford University provides an extreme example of the impact of university education and research on the economy (Arora, Belenzon, & Patacconi, 2019). It is estimated that nearly 40,000 companies can trace their roots to Stanford. These companies created an estimated 5.4 million jobs and generate annual world revenues of $2.7 trillion (Eesley & Miller, 2017).

The region's economy reinvents itself regularly by riding the constant waves of innovation (Henton & Held, 2013). Emerging industries create new infrastructure interlinking some of the new technologies with some of the old and helping to sustain the innovations. The key to success is learning to ride waves of change generated by creative destruction and supported by infrastructure networks. Knowledge transfer and R&D spending by the valley firms, knowledge spillover between firms and availability of venture capital funding keeps innovation and new technology development as a continuous process in Silicon Valley. Other regions could follow the Silicon Valley model according to Henton and Held (2013). They have to focus their investment in elements of an innovation ecosystem and adapt to the inevitable cycles of creative destruction.

3.3.3 Stockholm, Sweden

> "Sweden is a strong knowledge-based economy, well integrated in global value chains, which ensures high standards of living, well-being, income and gender equality, as well as a high environmental quality to its inhabitants. Sweden's strong economic performance is rooted in a highly skilled workforce and high investment in R&D. Gross domestic expenditure on R&D was 3.3 percent of GDP in 2016 and well above the OECD average." (OECD, 2019c)

Stockholm region in Sweden is ranked as the most knowledge intensive region outside of the USA (Innovation Stockholm.2018). The region accounts for about one third of the total R&D expenditure in Sweden and every third start-up company. There is also a high density of many small research-based companies in the Stockholm region that play a crucial role in attracting international talent, investments and capital.

The strengths of the Stockholm innovation system can be seen in the high number of patent applications at the European Patent Office (Diez, 2002). This can be correlated with the higher qualification levels of the population in the Stockholm region (DFIR, 2019). The innovation

ecosystem of Stockholm is a positive example of the advantages of collaboration and networking resulting in an improved competitiveness, higher innovativeness and greater economic performance. Stockholm research institutes are very much engaged in new technology fields (Diez, 2002). Researchers from industry and academia work together in these centres of competence. In Sweden, the universities have worked closely with firms on applied research over many decades.

From 2012, the government invited all innovation ecosystem actors to pursue strategic innovation agendas within strategic innovation areas to contribute to economic growth and productivity (New Zealand Productivity Commission, 2021). The Swedish national and regional technology policy tries to encourage closer links between firms and research institutes. Private firms and public research institutes jointly establish centres with the aim to accelerate the process of transferring scientific findings into commercial products.

The Swedish agency for innovation systems, VINNOVA, created the triple helix model and collaboration across institutions has become a condition for research funding in Sweden (Leydesdorff & Strand, 2013). VINNOVA promotes the formation of regional innovation systems with a vision to be a world leader in research and innovation (Vinnova.2020). It promotes collaborations between firms, universities, research institutes and other ecosystem partners.

Sweden has the top position in the European Union with respect to the gross national expenditure in R&D and in number of researchers per capita (Diez, 2002). The private sector is the driving force within the national R&D system with nearly 68 percent of all spending in R&D coming from them. According to Soursa, there are large international corporations in Sweden that are active in R&D which enables high expenditure on R&D in the private sector (Suorsa, 2007).

3.3.4 Denmark

Denmark is an innovation leader in the European Union as well as globally (Knudsen et al., 2018). Denmark's innovation system is ranking second among European Union member States in 2017, behind Sweden and just ahead of Finland (OECD, 2019b). Denmark has an internationally recognised system for the support of knowledge based innovation (Knudsen et al., 2018). The application of Danish industrial R&D in firms is supported by specialised R&D institutions through an efficient knowledge dissemination system. Danish R&D intensity is relatively high and is about 3 percent of GDP. The private sector performs about two thirds of all R&D in Denmark. The Danish R&D and innovation system is also very productive in terms of patents and research commercialisation. Patents from Denmark accounts for 6.24 per billion GDP in 2015, which is well above the European Union average of 3.53.

The Danish government is supporting more than 22 nationwide innovation networks which are designed to facilitate interaction between universities, research institutes and firms in different industries. The innovation networks are designed to facilitate knowledge exchange between R&D performers including firms. Innovation Ready Enterprises (IREs) are enterprises that have the potential and capacity to develop through knowledge based innovation (DFIR, 2019). The Danish Government has also launched a "Disruption Council" that brings together policy-makers and experts in Denmark to discuss how to seize opportunities of technological changes in the best possible way (OECD, 2019b).

The Innovation Agent Programme is operated by a network of 35 competent innovation agents from 8 independent research and technology organisations in Denmark (Innovation agent program.2020). The innovation agents offer knowledge and guidance to SMEs in the field of technological innovation and business development. Through an "innovation check-up", the innovation agent examines the company's processes, products, market approach, organisational structure and strategy in order to identify opportunities for technology driven innovation. An innovation check-up nudges the SME to review and renew its commercial basis and to improve its innovation capacity and activity levels.

Denmark is gifted with some of the biggest international firms. One example is the large pharmaceutical firm Novo Nordisk, which is the largest company in one of Europe's strongest biopharma clusters (New Zealand Productivity Commission, 2021). The firm has strong research links with more than a third of its researchers working closely with Danish research institutions. The skills and knowledge developed within the cluster can be shared across large firms in different industries too which is very good example of knowledge spillover effect.

3.4 Key Findings

Innovation doesn't occur in a vacuum. It is part of a national system that is influenced by macroeconomics, geography, culture and history (Raine et al., 2011). Successful regional innovation systems have been associated with interactions based on cooperation and trust, a culture of learning and a sense of community. Innovative firms make use of the local knowledge sources by cooperating with different actors so as to develop a vibrant ecosystem where innovations flourish.

The regional ecosystems act as a link between the local and national economy and also between other competitive regions in the world. It would be wrong to interpret regional innovation systems as being isolated from the national or international context (Diez, 2002). The most effective interventions in regional innovation ecosystems involve encouraging collaboration between firms

and between firms and educational and research organisations so that there is easier access to knowledge and resources.

Doloreux and Parto (2005)argues that the innovative performance of regions is improved when firms are encouraged to become better innovators by interacting with other actors within their region and beyond. The institutional characteristics of the region, its knowledge base and knowledge spillover represent important basic conditions for promoting innovation.

There is a widespread recognition that for New Zealand to prosper, it needs to break the commodity habit and instead forge an economy built on knowledge and innovation (Raine et al., 2011). Only an economy geared to producing high value goods and services is able to deliver the prosperity that the people desire. Transformational change requires actions that stems from a new way of thinking and mindset. It arises from a culture of creativity and risk taking, in which individuals are able to develop the skills to implement new ideas and access the world markets.

Successful innovation ecosystems show greater collaboration and knowledge sharing between ecosystem partners (especially university – industry – government). These ecosystems are giving more importance to applied research and have entities to commercialise and create value out of university and research institutions. The top ecosystems have managed to channel the accumulation of academic knowledge for joint innovation activities and combine the related outcomes with the market-driven commercialisation processes. The main challenge for the successful development of the ecosystems lies in their ability to extend the value network collaboration closer to the marketplace and complement the pure technology-push approach with a market-pull type needs analysis for penetrating a wider market segment.

Other main difference observed is regarding the innovation policy and its implications on the regional as well as organisational level innovation ecosystem. Government innovation policy makes sure that there is collaboration and knowledge sharing happen between different entities in the local ecosystem. There is a strategic approach and long-term vision by countries such as Finland, Sweden and Denmark. Moreover, there is a clear innovation policy in those countries and New Zealand as a nation is lacking on this.

World-class R&D infrastructure and platform are the necessary building blocks for initiating local innovation processes and attracting global talent to the ecosystem to strengthen the local knowledge and asset pools. New Zealand investment on R&D is considerably less and from this a considerable portion is still going into traditional industries. New Zealand innovation ecosystem seems to face continuous challenges in attracting adequate numbers of entrepreneurs,

businesses and talent which are required to create a vibrant system. It lacks the critical mass which is required for a sustainable model. The immigration policy, lack of attractive job opportunities, lack of knowledge based and technology oriented businesses as well as the cost of living in the country is preventing attracting talent to the country. Even New Zealand talent is going abroad and this brain drain is hampering the growth of innovation ecosystem.

Universities play an important role in innovation ecosystems. In addition to developing human capital and advancing technology, they are increasingly expected to participate as economic development partners with industry and local, state, and national governments. In the case of New Zealand there is a lack of industry funded postgraduate and PhD programs and applied research is not being encouraged. This is not the situation in the successful ecosystems under study.

All the comparable innovation ecosystems have several world leading firms whereas New Zealand companies are lacking the size and resources which are required to support an innovation ecosystem within the firms as well as the company acting as an anchor firm in the ecosystem. Hence it is required to find a new structure of ecosystem build up in the New Zealand economy within the challenges that is inherent in it. A close examination of organisational dynamics and its interaction with the external innovation ecosystem is to be conducted to describe a sustainable ecosystem structure.

3.5 Summary

The chapter looked at the New Zealand innovation ecosystem and mainly focused on the innovation and research policies. The picture that we get is of an ecosystem which is at the development stage and one which has a lot of potential for growth. The main drawbacks are the cultural and aspirational factors combined with the low spending on R&D, especially by the private sector. There is room for greater collaboration and knowledge sharing between all the actors in the ecosystem. New Zealand also needs to diversify its export by giving equal or more importance to knowledge and technology-based products.

Comparative study on other regional ecosystems and national innovation systems was also done. The Nordic countries have programmes, institutions and policies that are visible proofs of the benefits of greater collaboration and knowledge sharing among ecosystem partners (Raine et al., 2011). They have adopted a systemic approach to innovation and worked on the relationships between all elements in the ecosystem. Denmark, Finland, Sweden and Silicon Valley gives examples of successful innovation ecosystems and the need for a holistic view which will help to drive more effective innovation strategies.

Another observation is the effect of a national innovation ecosystem on its regions and the way citizens perceive innovation. A national innovation strategy will have a positive effect on the general perception and generates innovation creating activities from regions, firms as well as citizens. The cultural effect of unlearning and being ready to change is one major result of the positive attitude towards innovation and creativity. Positive attitudes create the climate for collaboration and knowledge sharing which in turn make the right cultural changes and it forms a synergetic loop. It all point towards the close relation between the national ecosystem with regional and firm level innovation ecosystems.

4.0 Research Gap and Methodology

4.1 Research Gap

Innovation ecosystems are gaining in importance and popularity in both innovation and strategic management (Klimas & Czakon, 2021).Innovation ecosystems are attributed with exerting a multilevel impact on innovation: they enhance innovation capability (Pellikka & Ali-Vehmas, 2019) and the innovation performance of actors (Song, Cao, & Zheng, 2016) , as well as increasing the innovation performance of the entire ecosystem (Talmar et al., 2018). Current research in ecosystems focus on innovation ecosystems, knowledge ecosystem, business ecosystems, digital platforms and the development of ecosystems. Existing research has seldom broken down an innovation ecosystem and investigated the sub-dimensions of it. Details of organisational structure of innovation ecosystem and its development process are not explored enough in current literature.

Innovation ecosystems are not confined to a single industry; instead, they form around a specific application or innovation and thus consist not only of companies but also include other actors that contribute to the innovation process as a whole, from exploration to exploitation (Schroth & Häußermann, 2018). They developed a definition of collaboration strategies in innovation ecosystems as instruments to facilitate the creation, exchange, and transfer of knowledge in dynamic ecosystems with the aim to develop unique competencies and resources in order to foster competitiveness. Our study reveals that companies adopt different collaborative strategies within innovation ecosystems, aiming at radical as well as incremental innovations. Study reveals that the development of long-term, strategic partnerships can be of particularly high added value for companies, although the initiation phase to establish such partnerships can be more complex.

The concept of an “innovation ecosystem” is the latest in a list of similar concepts—including “innovation districts,” “innovation clusters,” and “national innovation systems”—that reference geographically located innovation at a national, regional or local level (Heaton et al., 2019). Regional and national differences in how innovation is fostered and supported matter significantly (Lundvall, 2007). More specifically innovation is affected by the way innovation initiatives are set up which govern interactions between regional level and firms. Silicon Valley or the Boston region in the USA has created a regional innovation mind set which influences firms and this interaction has a multiplying effect on the overall innovation success (Saxenian, 1996). Similar interactions can be found in other innovation clusters and hubs around the world.

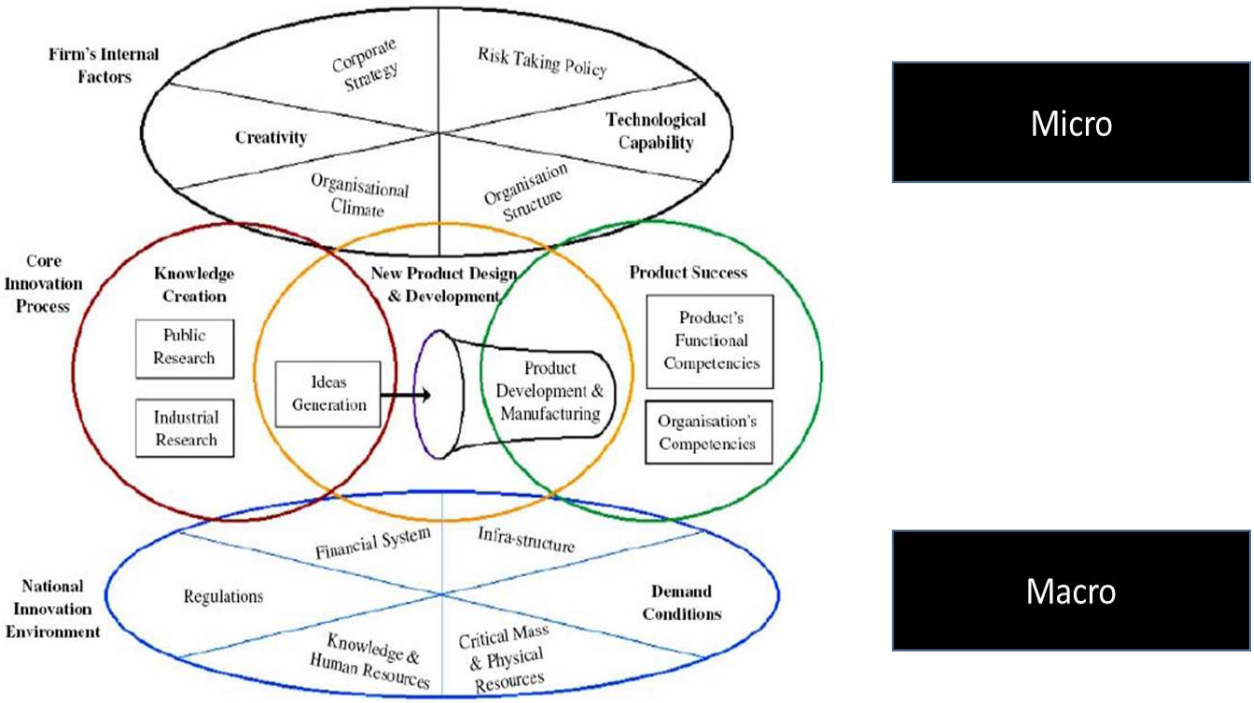

Figure 4-1 Innovation System model Galanakis (2006)

Galanakis (2006) proposes an innovation model based on the systems thinking approach as shown in figure 4-1. In the model there is a clear distinction between the internal organisational factors and the external innovation ecosystem. The core innovation process is being supported by the firm's internal factors as well as the national innovation environment. However, the model has been developed from the viewpoint of product innovation. The micro (organisational) and macro (regional and national innovation systems) view of the innovation ecosystem is relevant for further studies. There has been a lack of analysis into the national effect of innovation and R&D policy on the regional and firm level interaction between ecosystem elements in the case of New Zealand. A holistic analysis is required to understand the organisational dynamics within the macro level view of the innovation ecosystem.

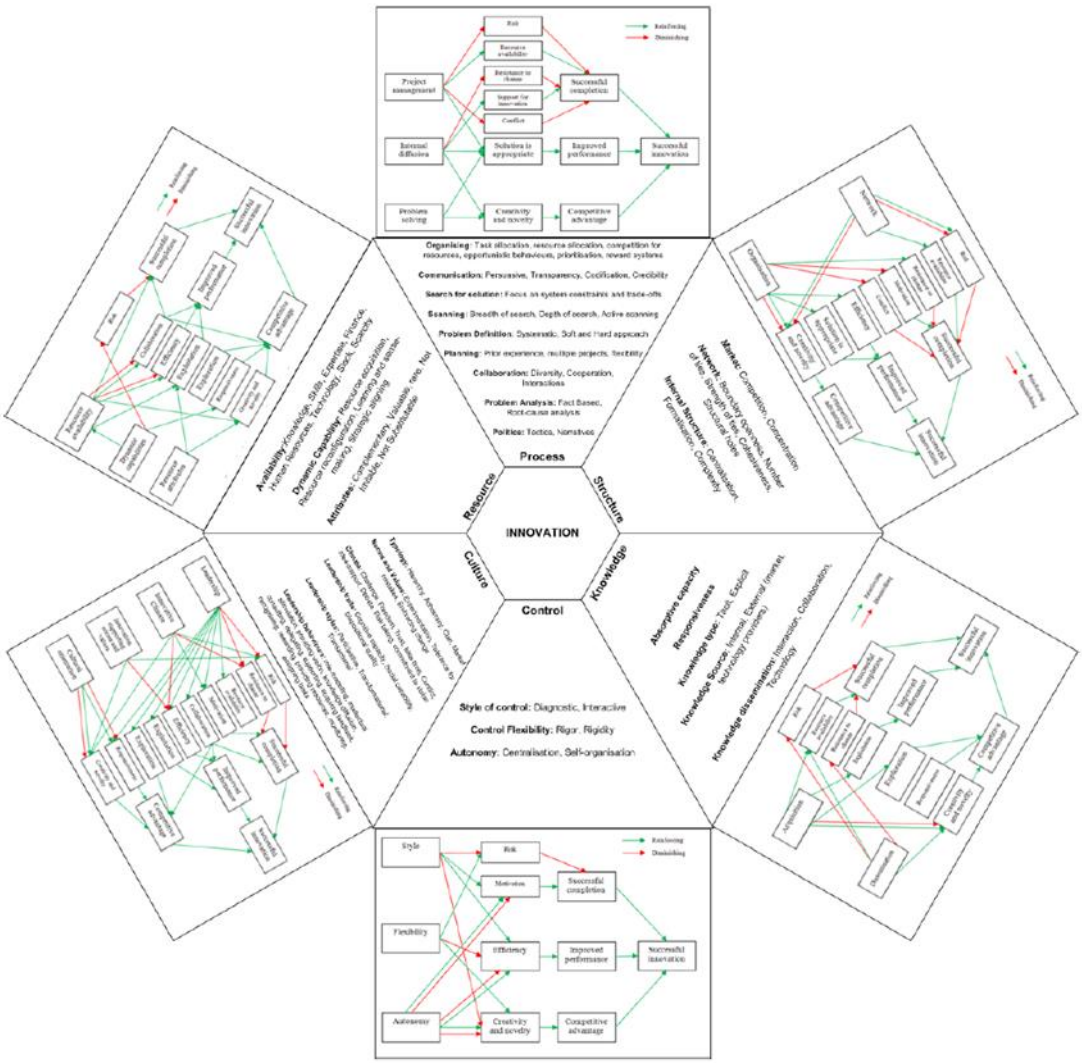

Figure 4-2 Innovation Prism model

Innovation prism model looks at the systems and processes with a holistic perspective to find levels of innovation capability within an organisation as shown in figure 4-2. The assessment framework is looking at organisation's innovation capabilities from six different perspectives: process, knowledge, structure, culture, control and resources (Shahbazpour, 2010). One disadvantage of this model is that it is more inward looking and does not account for the external interactions which is a characteristic of innovation ecosystems. Some of the parameters described in the model is of significance when we are looking at the organisation level interactions. There is a scope of new knowledge addition by looking at the external interactions and which of the internal factors are influenced as a result of those interactions.

Existing research rarely deconstructs an innovation ecosystem and examines its subdimensions (Su et al., 2018). If one were to look inside an innovation ecosystem, one might observe that not all such ecosystems have the same architecture and internal collaboration models. It is essential to understand and take account of the link between micro and macro behaviours of ecosystem actors,

as well as the cooperative and competitive interactions among them, which affect the balance and dynamics of the ecosystem (Valkokari, 2015). Ecosystem boundaries could also be traced via geographical scope (local vs. regional vs. national).

The current research on innovation ecosystem looks primarily at the regional innovation eco systems and with emphasis on the triple-helix concept. The concept of innovation ecosystem has begun to infiltrate spaces more traditionally described by such concepts as innovation system, triple-helix or cluster. There are studies on the university–industry collaboration, open innovation and business ecosystems. But there is a huge gap in understanding the interactions between internal and external ecosystems and how to make this more effective. Like in a biological ecosystem, in an innovation ecosystem businesses and enterprises have interactions with other enterprises and the social cultural environment in which they operate. Sub-optimising of internal ecosystem initiatives has reduced the overall innovation effectiveness. This shows a need for a systems approach to the study of innovation in firms. A holistic look at the firm specific internal activities and how it can gain effectively by interacting among its internal initiatives as well as from external environment is required.

There are very few researches done within the New Zealand innovation ecosystem and especially with firms in the ecosystem. Within the national system there are regional innovation systems, and both of these will have an effect on the organisational level innovation dynamics. This research is trying to find the interactions between the internal and external dynamics between the firm, region and national level innovation ecosystems. Current studies on New Zealand innovation systems haven't touched this area of research. Hence the study is addressing a huge gap in the research area under focus and is valuable from a knowledge point of view.

This research has a contemporary relevance in the age of industry 4.0 and automation which is going to challenge the status quo approach of traditional organisations. A key differentiating factor for firms is going to be the capability to adapt and capture value from the new arising opportunities (Harper & Glew, 2008). Conventional innovation management approaches could become obsolete under the new scenario which is unfolding at a faster pace. The innovation process itself changes as a result of application of new organisational approaches and technologies (Dodgson et al., 2013). The current understanding of innovation ecosystem is limited. There is a need for firms to proactively create and leverage innovation ecosystems for enhanced innovation performance. The study is looking at the dynamics of innovation systems which could be applied in organisations dealing with advanced technologies and new advances in knowledge.

4.2 Scope of Research

The concept of ecosystems adopted in this research is that of something like biological ecosystems when there is constant interaction within and outside the system. There are internal and external ecosystems interacting with each other and both are interdependent. Innovation ecosystems function with internal organisation dynamics affected by the external environment and vice versa. These can be in the form of government innovation policies, innovation clusters, start-up companies, academic research, industry-academic collaboration, entrepreneurial mind set and many other societal factors. An innovation or entrepreneurial ecosystem may include many different actors such as entrepreneurs, innovators, venture capitalists, accelerators, vendors and academic institutions. As in living ecosystems there is a strong correlation between the external environment and the internal innovation culture in organisations.

Innovation eco system can also be viewed as dynamic and purposive networks in which participants co-create value (Adner & Kapoor, 2010). Ecosystem boundaries could be treated differently and on a meta-organisational design (Gulati, Puranam, & Tushman, 2012). Different boundary definitions could be applied to different purposes and perspectives. It is useful to think about ecosystems as an evolving community and each participant as members co-evolving with the system (Iansiti & Levien, 2004b; Li, 2009). New patterns could emerge and change the way of value creation in a firm.

The study is looking at the innovation ecosystem on a holistic basis and more specifically on the interaction of organisational internal dynamics with the external innovation entities. The best practices from a geographical innovation ecosystem can be adopted in organisations to create the right atmosphere for innovation. At the same time firms can position themselves better to receive the benefits of the external interactions.

The interactions within a firm could be influenced by the external environment and regional and national policies as shown in figure 4-3. Internal organisational dynamics and its interaction with the regional as well as the national innovation ecosystems is the core area of this thesis. Detailed analysis of Auckland region is done in chapter 2 and New Zealand innovation policy in chapter 3. This analysis is to be combined with the case study on New Zealand firms to reach a proper conclusion on the interacting mechanisms as part of the innovation ecosystem.

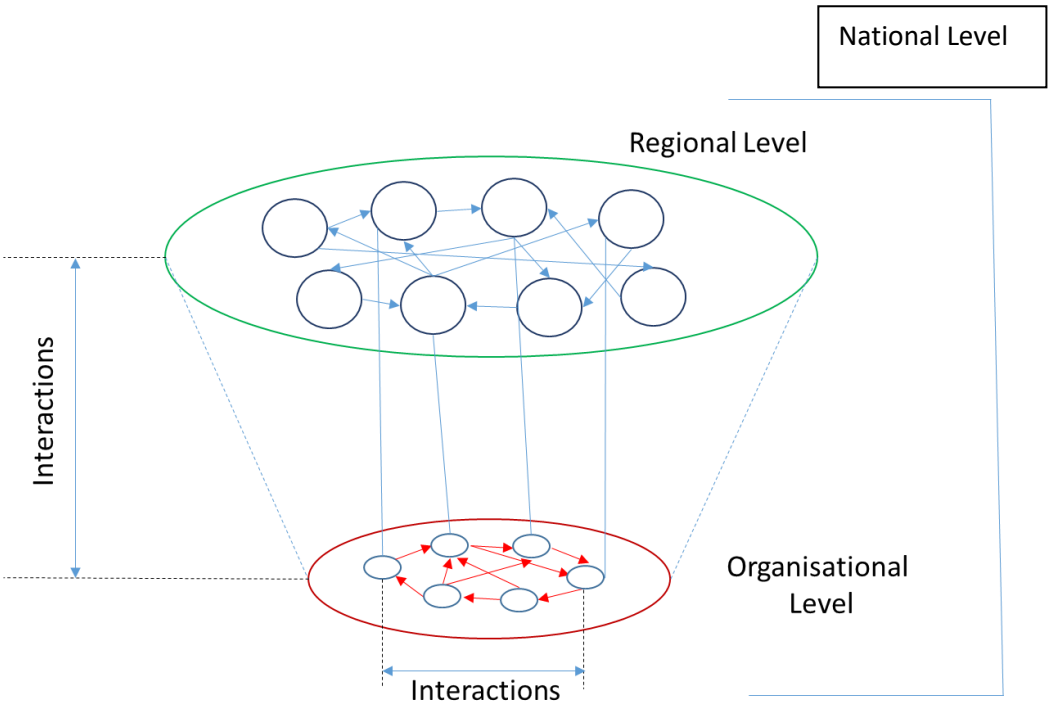

Figure 4-3 Network of interactions within the firm and with outside entities

4.2.1Study goals and assumptions

1. The dynamic interplay between the external and internal ecosystems and the synergy of activities will lead to sustainable innovation practices and long-term competitive advantage for the firm. The ideal way an organisation position itself to tap into the external innovation ecosystem and frame its internal ecosystem is a topic of interest to many firms.

2. It is possible to create synergy between a geographical innovation ecosystem and an organisational entity that thrives in that ecosystem. This requires the creation of an organisational innovation ecosystem to work in collaboration with the external environment.

3. There is a challenge to connect the firm to the broader ecosystem and this requires an understanding of the internal dynamics as well as external links.

4. The needs of the era of disruptive technologies are quite different from traditional management approaches. Firms need to have a fresh perspective on dynamic resources, collaborative innovation, and creating the right innovation ecosystem within the firm to be competitive in the new scenario.

4.2.2 Research Questions

1. What are the successful elements of firm specific innovation ecosystem practices?

2. What learnings from geographical and national innovation ecosystems can be incorporated in organisational innovation ecosystem?

Overall research question: What are the enablers and barriers to innovation ecosystems in New Zealand; based on detailed investigations into large firms and country policy?

4.3 Methodology

Here we try to address issues regarding selection of a research methodology and explain the rationale behind the selection. This is followed by research design in several phases of the study.

4.3.1 Issues in Research Design

Ecosystems have recently emerged as an important stream in organisation and management research (Phillips & Ritala, 2019). The ecosystem concept promises a systems view of organisational and technological phenomena beyond traditional firm boundaries. There is a need to take a holistic view of the diverse interacting elements across the ecosystem. As the number of components and the relationships between those components increases, the system becomes a complex system, making prediction of cause and effect more difficult. These complex adaptive systems involve many components that adapt or learn as they interact and organise without being controlled or managed by any singular entity. The researcher must engage with the ecosystem and actors in the wider environment to better understand the system.

Innovation is a complex and diverse organisational phenomenon (Damanpour, 1996). Innovation study involves a broad range of individual perspectives and disciplines such as engineering, psychology, economics, management, geography and sociology (Fagerberg, Mowery, & Nelson, 2005). Innovation management remains an interdisciplinary endeavour, attracting scholarly contributions from fields that include economics, sociology, psychology, engineering and management, bringing different traditions and perspectives (Gopalakrishnan & Damanpour, 1997; Ritala, Schneider, & Michailova, 2020). In-depth understanding of contextual information is crucial in identifying the elements and its interaction. Hence action research may be a better approach than traditional case study method. This will also provide the researcher with the opportunity to capture inherent elements and insightful patterns which are essential for innovation research (Platts, 1993).

Innovation process is an example of a complex adaptive system. Complex adaptive systems comprise many, densely interdependent parts. They do not obey simple laws of cause and effect. They are not controllable or easily predictable. To have a deeper understanding of the complex adaptive systems it is required to involve with ongoing processes in organisations for most of the

time and occasionally move out of the system to view it from a distance (Ottosson, 2003). Researchers in management who perform their studies of organisations from a distance and not from inside the processes only receive information that may have been filtered and adjusted. To make academic research relevant, researchers should try out their theories with practitioners in real situations and real organisations (Avison et al., 1999). Developing deep understanding of such complex subject of study, calls for a complex and creative research design. This cannot be achieved through preserving methodological purity (Huberman and Miles, 2002).

The limitations associated with data collection through surveys and/or conversational interviews commonly lead to a superficial view of the participating firms; missing in-depth understanding of contextual information, that is crucial to the understanding of the dynamics of the complex phenomenon which is innovation. Innovation involves a lot of tacit knowledge and the transfer of this type of knowledge occurs with deeper connections. Insights are being picked up through active interactions with the research participants. Organisational dynamics is one core aspect of the innovation capability and to capture the real sense of activities it is advisable to have close contact with the firm. Under these circumstances a more involved participation is suitable.

4.3.2 Different approaches

Research methodology is a strategy or plan of action that shapes our choice and use of methods and links them to the desired outcomes (Crotty, 1998). Qualitative methods focus on the human experience and the meanings felt by individuals living the experience and it gives deeper insight into complex human behaviours that occurs as a result (Mason, 2006). The primary goal of qualitative research is to interpret and document an entire phenomenon from an individual's viewpoint or frame of reference. Participatory Action Research (PAR) is one option in qualitative research methodology that should be considered for in-depth analysis of complex systems (MacDonald, 2012). It is a qualitative research methodology which fosters collaboration among participants and researchers.

A strength of qualitative methods is their value in explaining what goes on in organisations. With the participatory action research, the researcher is in more active contact with the client firm. One encounters the whole range of the organisational conditions in action research namely interpersonal processes, group dynamics, cultures, values and norms. Unfurnished data and impressions can be gained in a qualitative way, as opposed to traditional research methods. When conducting participatory action research unspoken information is of great value and will be captured in a natural way.

Although action research offers great advantages of connecting academia and practice, it is surprisingly underutilised in innovation management (Guertler, Kriz, & Sick, 2020). It is an applied research method in collaboration with practitioners, which simultaneously focuses on practical problem-solving and expanding scientific knowledge. It helps the industry to solve hard problems with a combination of theory and practise involving participants and then reflecting on the outcome (Kaplan, 1998; Starkey & Madan, 2001). This research method is more demanding compared to traditional methods. It requires use of emotional skills, appropriate experience and knowledge and good personal skills when researchers act as project leaders or team members in the case organisation.

Action research simultaneously assists in practical problem-solving and expands scientific knowledge as well as enhances the competencies of the respective actors (Hult & Lennung, 1980). The interpretation and analysis of the data will be undertaken in collaboration between the action researcher and the client. The researcher using an action research approach will be studying interconnections, interdependencies and the dynamics of a total functioning system rather than isolated factors. Participatory action research involves planned interventions in real time situations and a study of those interventions as they occur which in turn informs further interventions (Coghian, 2001).

The fundamental aim of participatory action research is to improve practice along with producing knowledge. The central idea is that participatory action research uses a scientific approach to study the resolution of important social or organisational issues together with those who experience these issues directly (Coughlan & Coghlan, 2002). This is research concurrent with action and the goal is to make that action more effective while simultaneously building up a body of scientific knowledge. When action researchers engage and try to understand and shape what is going on, they are engaging in their own experiential learning, reflecting, interpreting and acting. Reflection is the process of stepping back from experience to process what the experience means with a view to planning further action.

According to Park (1999), participatory research is aimed at both generating knowledge and producing action and is driven by practical outcomes and theoretical understanding. By using the methodology of action research, practitioners could research their own actions with the intent of making them more effective while at the same time working within and toward theories of action (Dickens & Watkins, 1999).

The methodology used in this research is referred to as participatory action research. In this method, the researcher is embedded in the case organisation and participates in various change and innovation projects. It seeks to understand and improve the studied environment by introducing changes and evaluating it. At the heart of it is an inquiry process that researchers and participants undertake, so they can understand and improve upon the practices in which they participate. In participatory action research the researcher as well as the participant learns together. The researcher is not merely a bystander but needs to contribute toward the creation and discovery of a process. In a highly applied discipline such as innovation management action research complements other approaches as a rigorous methodology that combines theory generation with practical impact.

4.3.3 Challenges for the researcher

According to Susanne and Anna (2020) there are three challenges from employing action research: the researcher is both an outsider and an insider and the outcome is both general and specific. The study argues that action research for innovation management is most suited to exploring tacit aspects of practices and processes. Action researchers start with initial research questions but are aware that these can change based on new insights gained during an action research project. Results of an action research project can differ considerably from the initial project focus and anticipated trajectory.

Greenwood, Whyte and Harkavy (1993) argue that participatory action research is always a process that works effectively to link participation, social action and knowledge generation. In participatory action research execution of the research is a collaborative process between researchers and members of the firm under study. Action research always sets out two basic goals that is to solve a problem for the client and to contribute to knowledge (Ottosson, 1996). For the researcher that means being a management consultant and an academic researcher at the same time.

Participatory action research contrasts sharply with the conventional model of pure research in which members of organisations and communities are treated as passive subjects (Whyte, Greenwood, & Lazes, 1991). As we work with members of the organisation, we draw upon the research literature as well as our own experience. Action research involves an action researcher and organisation members who are seeking to improve their situation (MacDonald, 2012). Action research bypasses the traditional separation between research and application (Bradbury & Reason, 2003). Individuals in an organisation needs to actively participate in collaboration with the professional researcher throughout the entire research process. Participatory action research

requires time, knowledge of the community and sensitivity on the part of the researcher to understand the divergent perspectives.

In spite of careful selection of case companies, interviewees and framework there are challenges for case study research as pointed out by Eisenhardt and Graebner (2007). One of the main challenge in participatory action research or in any case study research is the possibility of lacking rigour in carrying out the research. Other major issue is related with the emotional and personal challenge in dealing with an active company environment. In order to reduce the above issues, it was decided to write a weekly review of the case study and also have frequent meetings with the company supervisor. The actions and feedback were reviewed, and suitable steps were taken to ensure the objectivity of the research. It also helped to stick with the plan even though the organisational priorities changes as the year progressed.

4.3.4 Research in practise

Sensemaking may be defined as an ongoing accomplishment through which people create their situations and actions and attempt to make them rationally accountable to themselves and others (Allard-Poesi, 2005). Participative approaches emphasise participation and interactions both as an ontological condition and as a research strategy. They consider that the only real sources of knowledge and meanings are to be found in active experience of the world. Participatory action research invites us to engage in sensemaking processes with the participants of the organisation under study and to reflect on these processes with them. Through direct participation and observations, the researcher aims to develop a thorough understanding of the dynamics of how change and innovation can be initiated, developed and implemented in the firm (Foster, 1972).

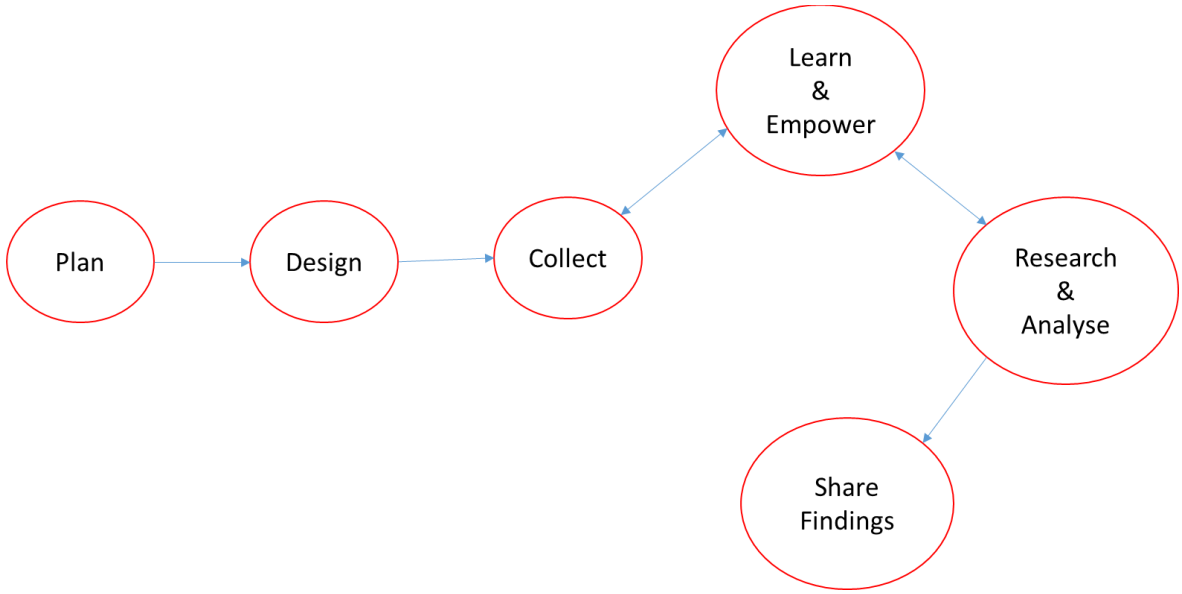

Figure 4-3 Research design using participatory action research

The detailed research design is shown in figure 4-3. The initial phase of the research is the planning and designing stage where the researcher as well as the innovation manager from the case study firm carefully reach an agreement of the project to be observed and the survey and interview part of the process. The method of data collection and analysis is discussed, and a mutual agreement is made with the organisation under study. The next phase is the data collection which is followed by learning and empowerment. Participatory action research aims to achieve empowerment of those involved in the study. The analysed research data is discussed with the participants and knowledge transfer and empowerment happens with each new action. There is an iterative cycle of data collection, reflection and action. Finally, the findings are shared with the organisation under study.

The researcher is allowed to participate in an innovation project at the firm and work closely with the innovation manager. This includes team meetings and strategic meetings with the executive, collaboration partners, clients and other members of the innovation team. Researcher will have weekly meetings with the innovation manager to provide feedback and to update on the innovation related activities. There are three data points: the survey data, interview data and observations from innovation project and organisational meetings.

Several provisions were put in place to ensure appropriate conclusions were reached:

1. Writing reflections on learning every week.
2. Discussion with the innovation manager on the findings.
3. Periodic updates with the PhD supervisor.
4. Participation in group meetings and workshops and involvement in innovation project.
5. Regular formal and informal critical reflections on the project with members of the research team and project partners.
6. Ongoing feedback from participants on draft reports and case studies. Doing subsequent interviews by asking respondents to verify interpretations and data gathered in earlier interviews.
7. Ensuring that a diversity of voices is represented in the evaluation report.
8. Illustrating evaluation case studies and reports with rigorously selected examples of data such as verbatim quotations from interviews and feedback questionnaires.

Multi viewpoint model of innovation developed by Zhang et.al (2013), is used as systematic tool for the participatory action research case studies. By sing this model, it is possible to systematically analyse and understand the dynamics that govern innovation ecosystem in the case company. Standard questionnaire will be used for the survey and by selecting a diverse pool of participants it is possible to reduce the inherent bias in firms. Follow up interview will be conducted to capture the fine details of organisational dynamics. The survey and interview data were periodically discussed with the research supervisor as well as case company supervisor to ensure quality control and avoid bias.

In participatory action research the researcher becomes involved in and contributes to the practitioner's world, and the practitioner becomes involved in and contributes directly to the research output (Eden & Huxham, 1996). Theory building as a result of action research will be incremental, moving from the particular to the general in small steps. Action research will almost always be inductive theory building research, the valuable insights are those that emerge from the process in ways that cannot be foreseen. The researcher not only has the roles of researcher and consultant but also is a subject of the research itself.

Deduction is used to find the conclusion when the preconditions and rules of the system are known (Menzies, 1996) . A deductive research approach starts with a theory based on the literature, which is narrowed into a testable hypothesis, then validated against observations (Haig, 2018; Trochim, W. M., 2005). Induction is used to find the rules of a system, but requires the preconditions and the conclusions to be known (Yu, C. H., 1994) . In an inductive research approach, a theory is built through observations to discover empirical generalisations of the phenomena under study (Haig, 2018). The figure 4-4 shows the deductive and inductive methodologies.

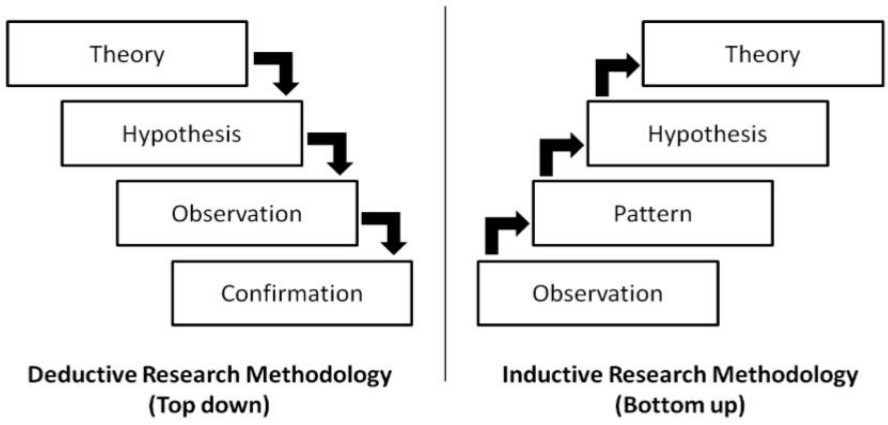

Figure 4-4 The deductive and inductive research methodology (Trochim & Donnelly, 2008)

In this study an inductive research methodology is used along with participatory action research. Detection of patterns will enable theory formation which is the main output of the research. Theory building in the social sciences and management should be inductive (Locke, 2007). The primary role of inductive research in scientific progress lies in detecting new phenomena of significance which may eventually lead to theory development. Induction concerns generalising results beyond the observations at hand (Woo, O'Boyle, & Spector, 2017). It involves taking observations and look for patterns in the data and relationships among variables that can be generalised from the sample.

4.4 Research Design

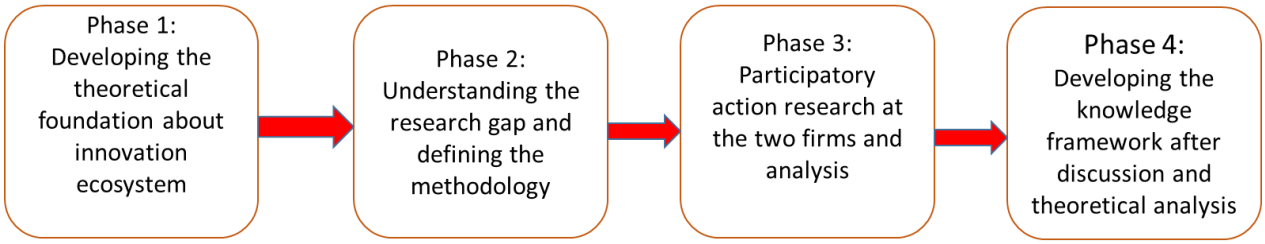

Figure 4-5 Research Design

The research is divided into four phases.

Phase 1: In this phase a holistic review of innovation is studied in detail and focus is given to corporate innovation, intrapreneurship, innovation ecosystem and reasons justifying the usage of ecosystem metaphor. Additional analysis is done on Auckland regional innovation ecosystem and New Zealand innovation policy. Meetings are conducted with all the key stakeholders in Auckland region. The objective of this phase is to give a good grounding to detailed further studies and research.

Phase 2: This phase is used to discuss different innovation systems and find the gap in literature and innovation ecosystem frameworks. Then careful analysis on the research methods is done which enabled the usage of participatory action research methodology for this study. Research questions are finalised and research design is explained.

Phase 3: The participatory action research of the firms happens in this phase of the study. Online survey, interview and observations from innovation projects are the key data points. The study and data at the first firm will give an initial advantage to approach the study at the second firm with more insights. But both the studies will be independently done one following the other. The output of this phase is an understanding of how the internal and external innovation ecosystems affect each other and the dynamics involved.

Phase 4: This final phase is for theory formation and knowledge development in particular. The interactions between various elements in the innovation ecosystems will give an insight into the dynamics of interaction. The output will be a generalised observation enabled through careful theoretical explanation of the interactions and foundational elements for an ideal innovation ecosystem in firms. Recommendations on New Zealand innovation ecosystem policies are done along with contributions to knowledge.

5.0 Case Studies

5.1 Introduction

Innovation refers to the creation and application of a new idea to create value (Boer & During, 2001). The ultimate goal of innovation is positive change to make something better. It can lead to increased productivity and overall revenue growth for the firm. Analysis of innovation capability in an organisation will be helpful to create awareness, introduce the concepts of innovation, to self-reflect on the current level of innovation and make improvements.

Innovation capability is the ability of an organisation to continuously reinvent itself and keep it relevant to the current market and ready to face any competitive challenges in the future. This needs a new way of thinking and an organisational culture which encourages calculated risk taking and a space to try out new ways of doing things. The effort organisations are putting into will benefit in developing more efficient and cost effective ways of functioning and hence the capability development will bring out positive results.

Innovation capability surveys can provide information on the innovation process at the firm level. They can identify motives and barriers to innovation and the kinds of innovation activity that the firms are engaged in. It can also provide information on firms' linkages with other actors in the ecosystem and on the impact of innovations on the economy.

5.2 Study methodology

The innovation capability study is designed to collect data from key stakeholders from different areas in the organisation. Efforts have been taken to get a representative sample and avoid any bias in the study. The survey and data collection were done through an online platform and followed up with a face to face interview. Feedback is collected from the survey responders on scores which show greater deviation from the mean score.

Additional questions were asked on innovation barriers, knowledge sharing, collaboration and innovation within their specific areas of work to understand the current state and on enablers of innovation and learning within the organisation. The survey data as well as interviews are analysed to identify gaps and opportunities for innovation as perceived by managers at the firm.

Further study is done on interactions within the organisation and on the key organisational initiatives. This is done to analyse the strength of coordination and engagement between various organisational initiatives which could act as catalysts for innovation as well as change management projects. Interviews were conducted with key stakeholders from various areas in the firm. A specific

innovation project was chosen for a deeper analysis of innovation process in the organisation and the learnings from it along with observational data is processed to reach study recommendation.

5.3 Innovation Capability Model

The assessment tool has been developed to gauge the organisational capability in the area of Innovation Management and to identify areas of excellence as well as areas of potential improvement (Zhang et al., 2013). This model looks at the systems and processes with a holistic perspective to find levels of innovation capability within an organisation. The assessment framework is looking at organisation's innovation capabilities from 6 different perspectives (Shahbazpour, 2010). The innovation process and knowledge capabilities have subcategories as shown below.

1. **Innovation process**

- Problem-solving is a mental process to overcome obstacles and find a solution that best solves the problem. Innovation is at its core a problem solving process.
- Internal dissemination is the process in which an innovation is communicated through certain channels over time among the members of a social system.
- Project management is concerned with describing and organising the project, which concentrate on the distribution and mobilisation management, resources deployment and minimising risks.

2. **Knowledge**

- Knowledge acquisition is a process of individual and organisational learning. It involves seeking and discovering new knowledge.
- Knowledge dissemination is the power of knowledge that is transferred and then deployed through action.
- Knowledge responsiveness is the ability to respond and make-use of the diverse knowledge which an organisation gains or has access to.

3. **Structure** is concerned with the arrangement of entities internal and external to the organisation and their relationship with respect to flow of information and resources.

4. **Control** is the mechanism to make decisions about whether the innovation project should continue, permanently stop, be placed on hold, be modified or select appropriate solutions.

5. **Culture** is concerned with norms, values, meaning, symbols and rituals shared by members of the organisation, describing "how things are done".

6. **Resources** are used to develop and deliver innovative products and processes. Having the right type and amount of resources are critical for successful innovation.

5.3.1 Maturity Level

The innovation capability model defines five maturity levels:

1. Initial: Process unpredictable, poorly controlled and reactive
2. Managed: Processes characterized for projects and is often reactive
3. Defined: Processes characterized for the organization and is proactive
4. Quantitatively Managed: Processes measured and controlled
5. Optimising: Focus on process improvement

5.4 Case Study 1 Air New Zealand

5.4.1 Introduction

Innovation capability analysis in an organisation will be helpful to introduce the concepts of innovation, create awareness, to self-reflect on the current level of innovation and focus on areas which needs improvement. This analysis is done at Air New Zealand Airline Engineering and Planning (AEP) using an innovation capability maturity model survey developed at University of Auckland. The survey results and the follow up interview feedback is correlated in order to arrive at the areas to focus on and opportunities for improvement.

Further study is done on management initiatives and performance improvement programs at the organisation. It points to a lack of coordination in initiatives and the need to broaden the scope of various initiatives and make it current based on the market realities. The organisation needs an innovation strategy in alignment with airline's Go Beyond strategic framework.

Innovation needs to be viewed as a marathon rather than a sprint and requires a holistic view to address the fundamental factors. At the same time 'over-engineering' can negatively affect the creative process. The airline needs to emulate the success of customer centric innovation into business processes and back end operations. Creating an innovative culture takes time and needs an innovation strategy, framework and structures. Collaborative innovation and better engagement can help form a creative mind set and entrepreneurial drive in the organisation and create a culture change.

5.4.2 Survey result

The survey results and the interview feedback are analysed along with observations in order to arrive at the core message that the study conveys. Areas to focus on are found by looking at the innovation capability score and the consistency in feedback from the survey attendees. Priority is given to results with minimum variation in responses for each question category. The results show current levels of innovation capability for each parameter and specific areas to focus based on the score and the consistency of feedback.

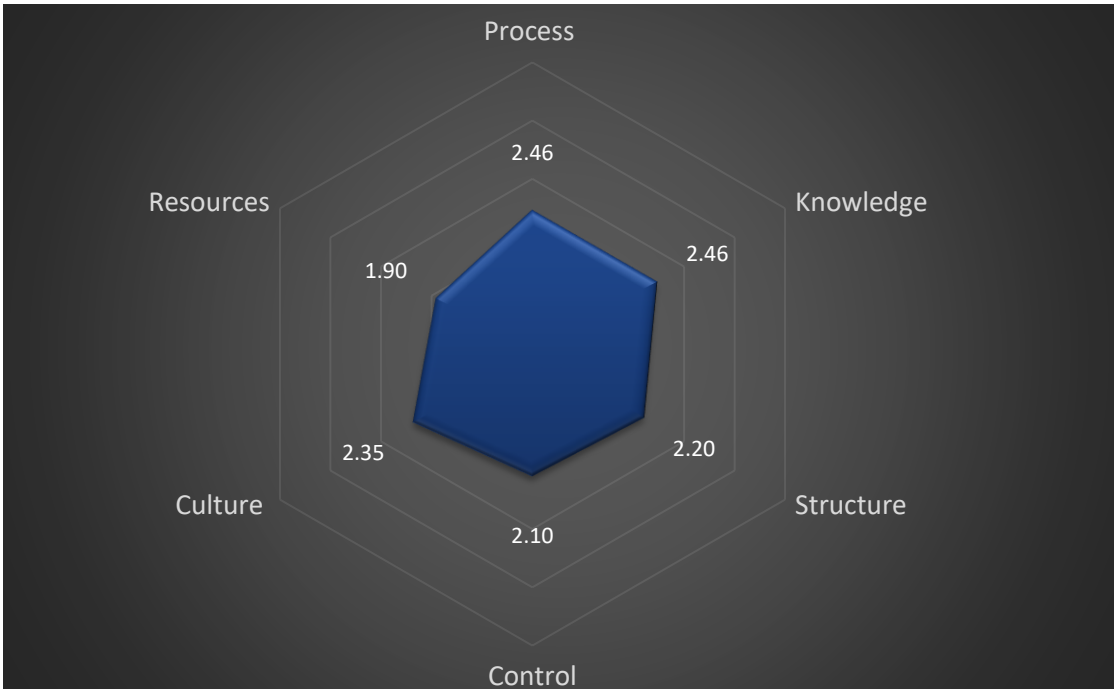

Figure 5-1 Organisation's Innovation capability level for each factor

According to the survey result the organisation has innovation capability level of 2 as shown in figure 5-1 which implies that the overall level of innovation capability is 'Managed' according to the capability maturity model. This shows that there is a huge opportunity for improvement in the innovation capability. These scores are indicative based on the capability maturity level and should not be considered as absolute values. When combined with interview feedback it can give a good insight into the current state of innovation capability and areas to focus on.

5.4.3 Data trends

The individual data as shown in figure 5-2 indicates reasonable variation and there are different factors which can cause this. The variation in interpreting the question, the tenure of participants in the firm, department differences and difference in individual perspectives, willingness to give an honest opinion and the effort that is put into the survey could have affected the final score. Considering all the above factors the survey result is to be understood in the context of the firm and the industry which it is part of.

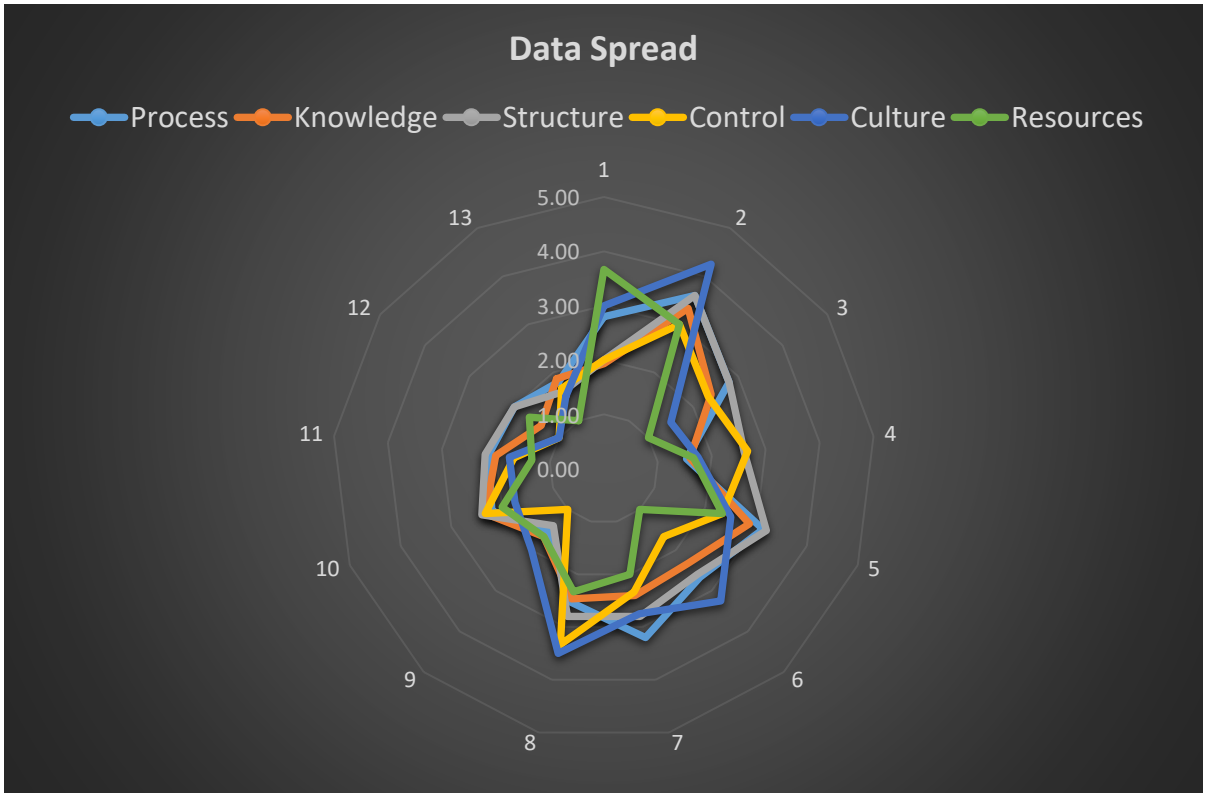

Figure 5-2 Data distribution of survey participants

The data distribution shows the capability level scoring given by the survey participants for the six perspectives defined by the model. Some of the questions in the survey are subjective and open to interpretation which might have caused the larger deviation from the mean. Diversity of opinion is also reflected in the data. It also shows the difference in perception of innovation capabilities by survey participants. This data trend is acceptable in a qualitative survey. The follow up interview and subsequent study of organisational initiatives will enable an unbiased analysis.

5.4.4 Interview Feedback

In-depth interviews with respondents revealed that it is important to get the right balance between innovation and the day-to-day operations. Innovation needs a dedicated approach with time and resources and a long term focus. It needs management initiative and involvement of right people as champions to drive it. There is lack of understanding about various types of innovation and the capability of execution. It is important to see the big picture along with the ability to execute rather than just being creative in approach.

"There are many other competing priorities. It is the operations that is the priority for an airline and at the end of the day it is a balancing act. If there is a

way, we can create efficiencies through innovation, then it can create resources and extra capacity to do more innovation."

Innovation based on need is the right approach for the organisation. Before jumping into solutions, it is important to define the problems that you are trying to solve and to balance the benefits to the resources and capital need. Entire scope needs to be considered while implementing solutions to the problem. Achieving the entire possibilities while implementing change is not happening now and the failure to capture the entire scope is costly.

"Airline day to day operations need not affect the space or time for innovation. It has to be built into the fabric and works with the system and in the process will create more productivity and enable people to do smart things."

Air NZ has a good perception among customers and brand recognition in terms of innovation. There is innovation happening on the customer facing side and the airline is comparatively good in that. But there is a lack of innovation when it comes to the Engineering and Maintenance side of the business. A lot of extra capacity and resources are hiding behind the layers and there is a lack of visibility to this.

"There are many functions which are redundant and these types of functions need to be deleted and automated and people will be able to focus on areas which are better usage of their time."

5.4.5 Barriers to Innovation

There are different reasons cited as barriers including the lack of diversity in the work force, time and resource constraint, financial implications, cultural factors including risk averse mentality and not embracing change etc. The other main barrier is the lack of collaboration with industry partners and other airlines for knowledge transfer as well as joint projects. There is also resistance in adopting someone else's idea rather than using a home-grown one.

"There is a significant lack of experience outside of aviation and in particular Air NZ. We are not realising there are other ways of addressing problems. People don't know what they don't know. There is lack of interaction with other airlines where there is scope for sharing of knowledge and collaboration."

Capability of execution and lack of champions who can drive innovation projects is one of the main constraints in successful execution of innovation projects. Identifying solutions have to be done after getting a clear vision and assessing the gap between the current and the future goal. Having the right risk mentality is also important. Expectation that you will always be successful the first time is not the ideal way to promote innovation. The timing of the projects, the people who are involved in the project and management initiative for innovation in alignment with the long term strategic goals of the organisation are all crucial factors for innovation success.

"Very often the final goal is not clearly defined and there are very few people who can see the clear picture. Once the goal is defined then the path can be defined in the right sequence rather than getting into a loop of never achieving the goal."

What innovation takes: Voices from the survey

The following are comments, edited for length, from respondents to Innovation Capability interview.

"We struggle from time to time to find the resources to put into innovative projects. Some teams are doing it but in general there is a constraint of right capability and availability of resources."

"We have fractionalised and split knowledge base. Lot of teams keep their knowledge to themselves (as tribal knowledge)."

"Resistance to change is prevailing. We often put business as usual in front and any change management project suffers because of not giving priority."

"There is an expectation that all innovations need to be successful, and the risk tolerance is low."

“People are not sure where to take the innovation idea to. Engineering doesn’t have an innovation leader and the multitier organisation structure can slow down the process.”

“The resource and time constraint are sometimes used as an excuse. It is about balancing the current priorities and the future needs.”

“No sharing of best practices and even if best practices are shared there is less acceptance - people think 'my way is the way to do it'.”

“The majority are not open to new ways of doing things. People have been here for a long time and hence it develops a tough culture.”

“Understanding of innovation and capability of execution are lacking. Lot of brainy people are there but turning it into reality is the challenging part.”

“People are the most important factor- projects are driven by people and willingness to work together is the key. It is the people that drive change and people can get in the way of the successful completion.”

“We are reasonably good at project management but struggle on change management. It is easier to get a small group interested and supportive but to include the wider business to it is hard to get through.”

“There is no proper way or process for sharing knowledge. Knowledge sharing actually empowers people.”

“People and resources are needed and someone has to go out and look for it. Otherwise, innovation will be a challenge.”

“There is a large risk of people retiring and hence the loss of individual knowledge. Needs to record the knowledge. Protective mentality is prevailing.”

“CAMO is a good example of collaboration. We took a variety of individuals around multiple teams. We see people openly talking to each other about processes.”

“Don’t underestimate the length of time and don’t expect innovation to be a short term process. Investment has to be long term and requires dedicated resource and money.”

“Changing scenario of the industry asks for more knowledge responsiveness.”

“Frustrated at the pace of innovation. Would like to see Air NZ leading rather than adapting. We need to hurry up and in other couple of years will be very far behind other airlines.”

"If we don't innovate, we die and the competition in the airline industry is forcing us to be more innovative. It is about productivity and automation is the way to do it."

"We need more diversity. We are self-contained as a country and organisation and not trying new things."

5.4.6 Collaboration Study

A proven industry framework is used to analyse the collaboration barriers in the firm. The framework which is developed in MIT after surveying executives in 107 companies is developed to identify the barriers to collaboration and their causes (Hansen & Nohria, 2004). According to the framework the four barriers to interunit collaboration are:

1. Unwillingness to seek input and learn from others.
2. Inability to seek and find expertise.
3. Unwillingness to help.
4. Inability to work together and transfer knowledge.

Collaboration Study Results

After comparing the obtained score from the sample at Air NZ Engineering and Planning to the model framework it is found that there is collaboration barrier which is a problem in two categories and a potential problem in the other two categories.

Barrier is a problem	Barrier might cause some problems
Inability to seek and find expertise	Unwillingness to seek input and learn from others
Unwillingness to help	Inability to work together to transfer knowledge

"We are talking about collaboration but not doing much. Outside collaboration is not happening and because of the belief that we know too much. Number 8 wire mentality is very much prevalent… it can be good but other airlines are collaborating more and there is a worldwide opportunity for that."

The main barriers for collaboration in the firm are:

1. Employees often complain about the difficulty they have locating colleagues who possess the information and expertise they need.
2. When faced with problems, employees strive to solve them by themselves without asking for help from outsiders.
3. Employees have great difficulties finding the documents and information they need in the company's databases and knowledge management systems.
4. Employees find it difficult to work across units to transfer complex technologies and best practices.
5. Employees have not learned to work together effectively across organisational units to transfer tacit knowledge.
6. Experts in the company are very difficult to locate.

5.4.7 Key Findings

There are several practices in the airline industry which are shaped by the organic growth of the sector throughout several decades. Operators who are having a small market under their control have shaped their own way of doing things. Air NZ which has never faced considerable competition have shaped an organisational mind set which is based on individual expertise and working in silos. There is a lot of knowledge and expertise with different individuals at certain areas of the organisation which are valuable. Better collaboration and cross functional project teams could tap into the individual knowledge and encourage more sharing. This is one of the main requirements for innovation or any other change management projects.

The main findings of the survey are:

Lack of Innovation Process Readiness

Innovation process consists of problem solving, internal dissemination and project management according to the capability model. Problem solving is one area which needs better focus, and this is core to innovation. Some of the issues raised are:

- Tendency to define problems vaguely
- Analysis focused on the symptoms rather than on the root causes
- Depending more on historical knowledge and gut feeling
- Lack of usage of problem solving tools and frameworks

Internal diffusion of the best practices of problem solving and innovative approaches is lacking in the organisation. There are no proper channels to communicate, share and push this information to other parts of the organisation.

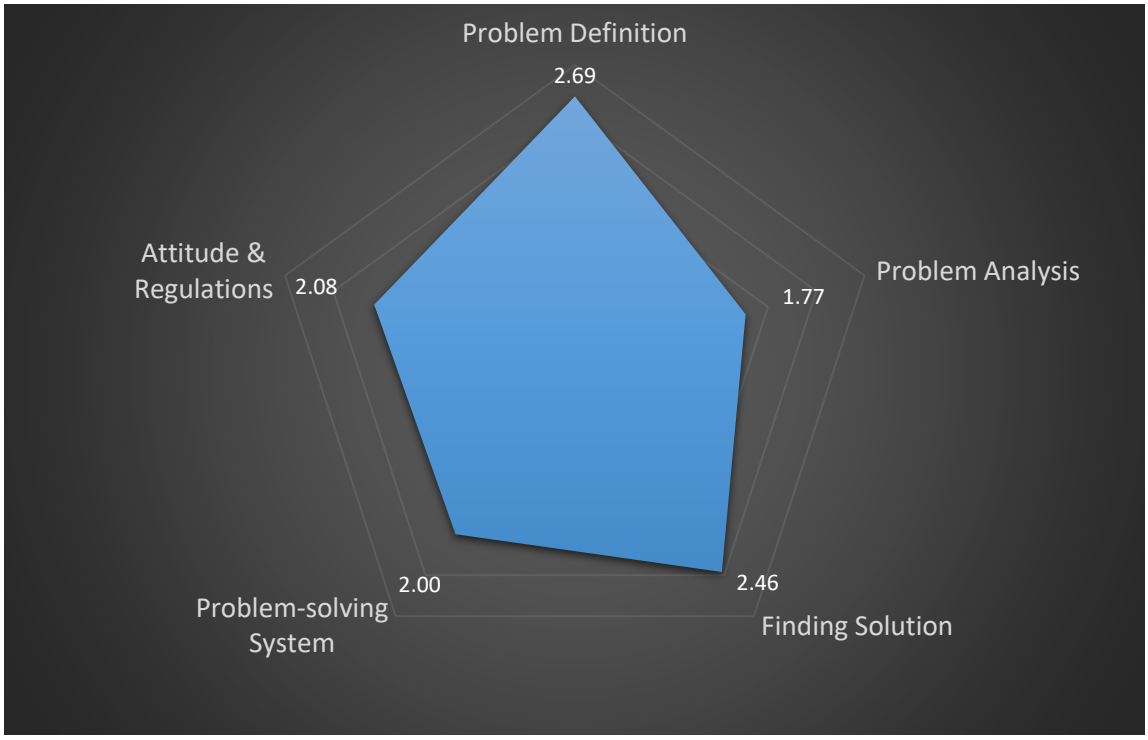

Figure 5-3 Problem solving capability level

Knowledge Management and Collaboration

Knowledge acquisition, dissemination and responsiveness are a major gap based on the assessment results. Lack of platforms for knowledge sharing, willingness of people to share knowledge, lack of agility and positive response towards new knowledge are some of the main feedbacks. Protectionism is prevailing and has become part of the organisation's culture. Teams are still working in silos and the level of communication and collaboration is limited. Having a knowledge management system, developing a culture of knowledge sharing and a training module to facilitate it are some of the positive suggestions which came out of the study.

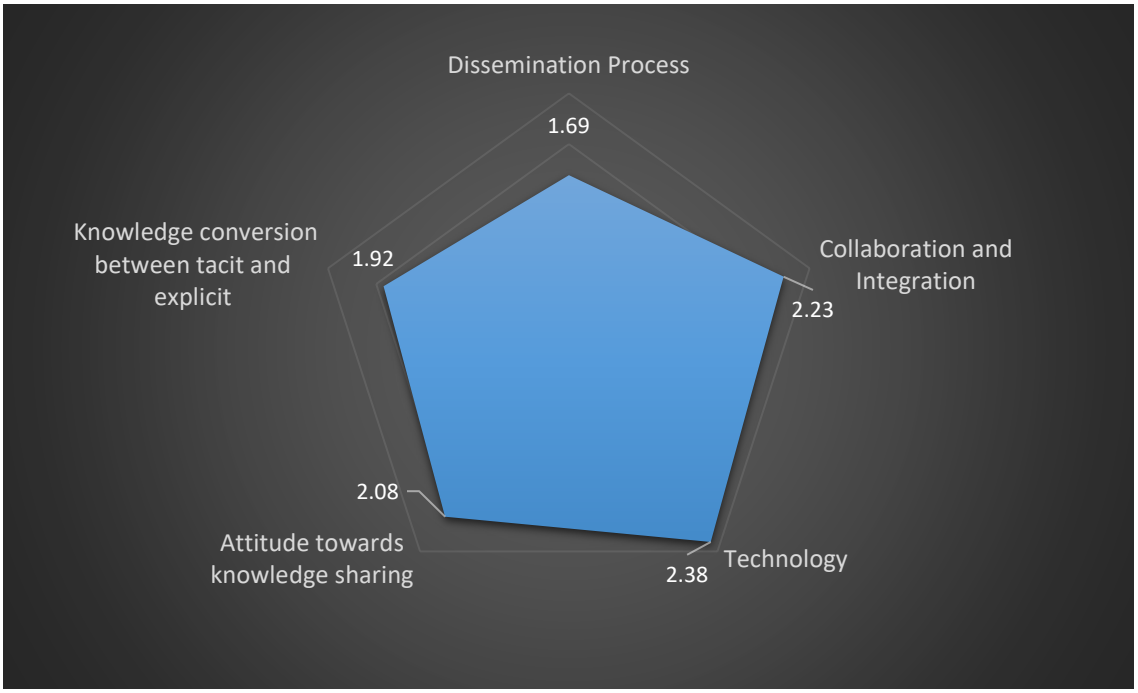

Figure 5-4 Knowledge Management capability level

Lack of Innovation leadership and supporting norms and values

Good leadership is also needed to encourage experimentation and support those who are innovative problem solvers. If a leader is only looking at the bottom line, then it is hard to find the space for innovation and creative problem solving. Innovation requires an investment in terms of time and resources which might not show results in the short term. It is important for the firm to see the value of long term benefits and competitive advantage. The organisation has to see that, to be recognised as a market leader in innovation is itself a good position to be and will positively influence the internal dynamics. The firm lacks in providing a culture of change and innovation supporting norms and values. These are shown in figures 5-5 and 5-6 below.

"It is hard to focus on innovation if it is not an actual objective of the organisation. People like to talk about innovation but unless there is an organisational objective and plans in place it is not easy to take it forward."

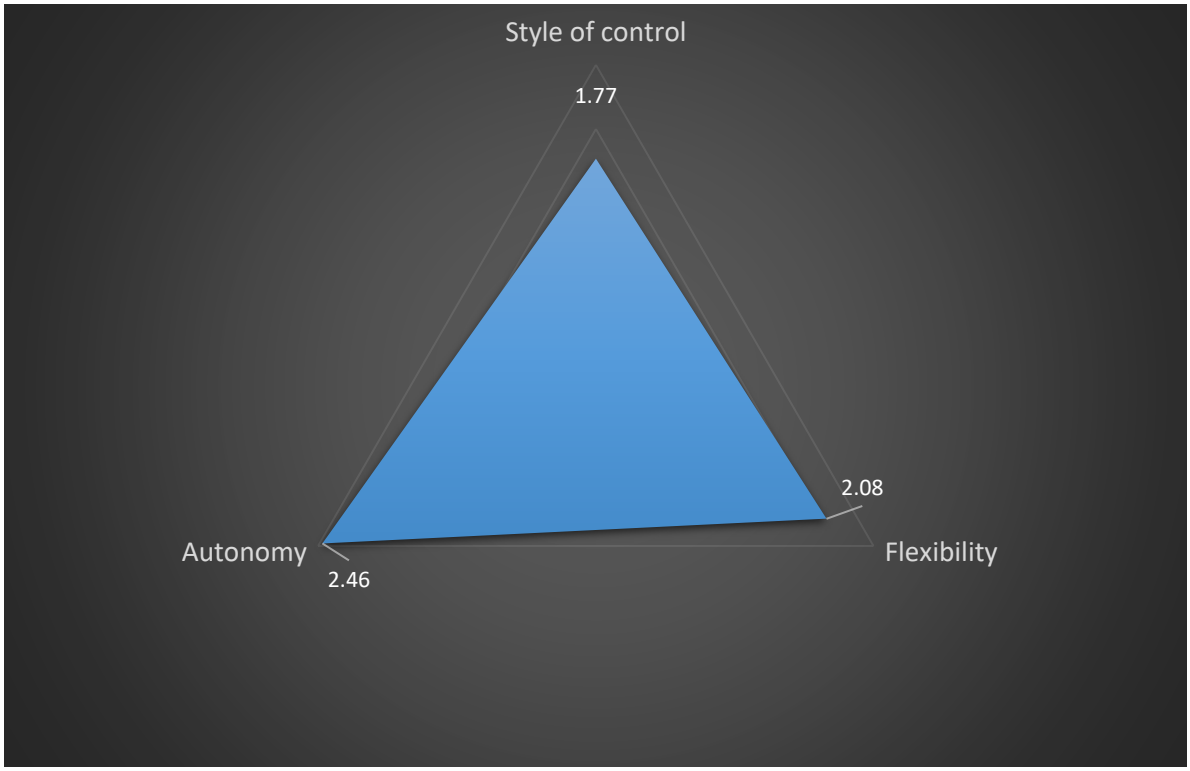

Figure 5-5 Control capability level

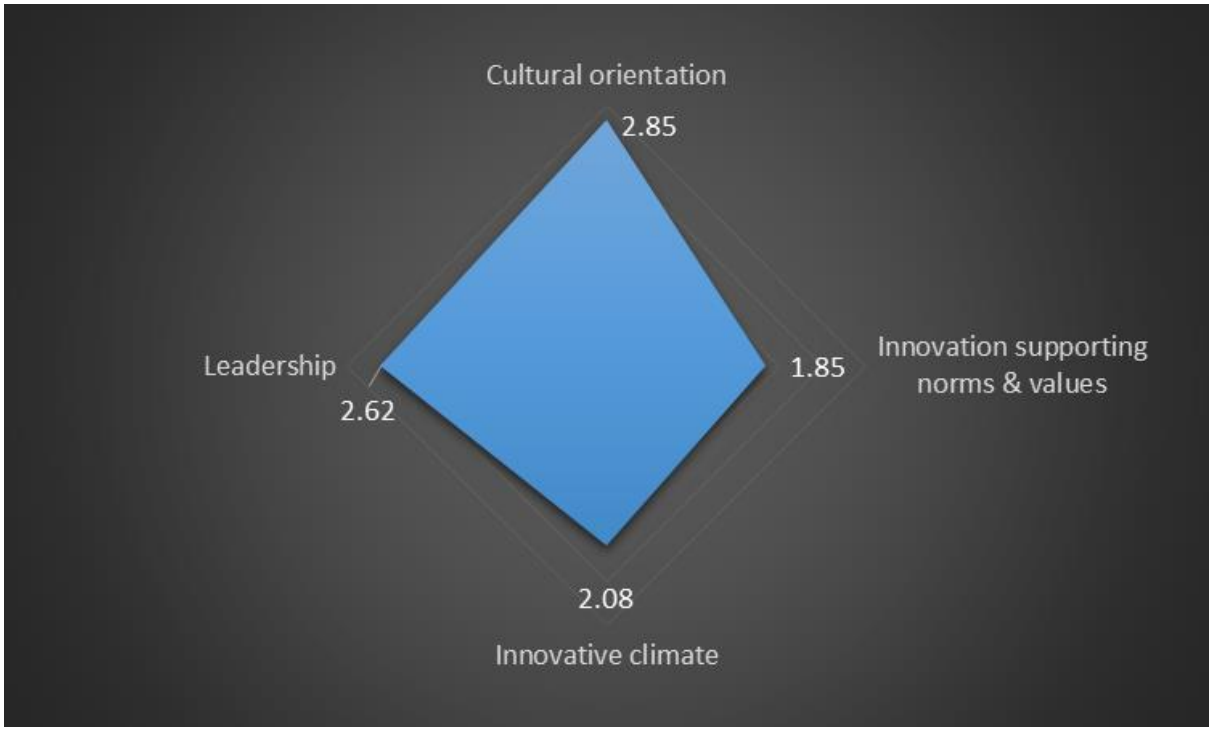

Figure 5-6 Culture capability level

Resources and Diversity of Thoughts

Innovation takes place in an organisation when it brings together the right combination of talents, incentives and opportunities. Availability of skilled resources and dynamic capability of resources are key innovation capabilities which are lacking in the organisation. Innovation projects suffer when the resources are constrained, or projects being pursued with more traditional management structure. Diversity and outside industry experience are also lacking in the organisation.

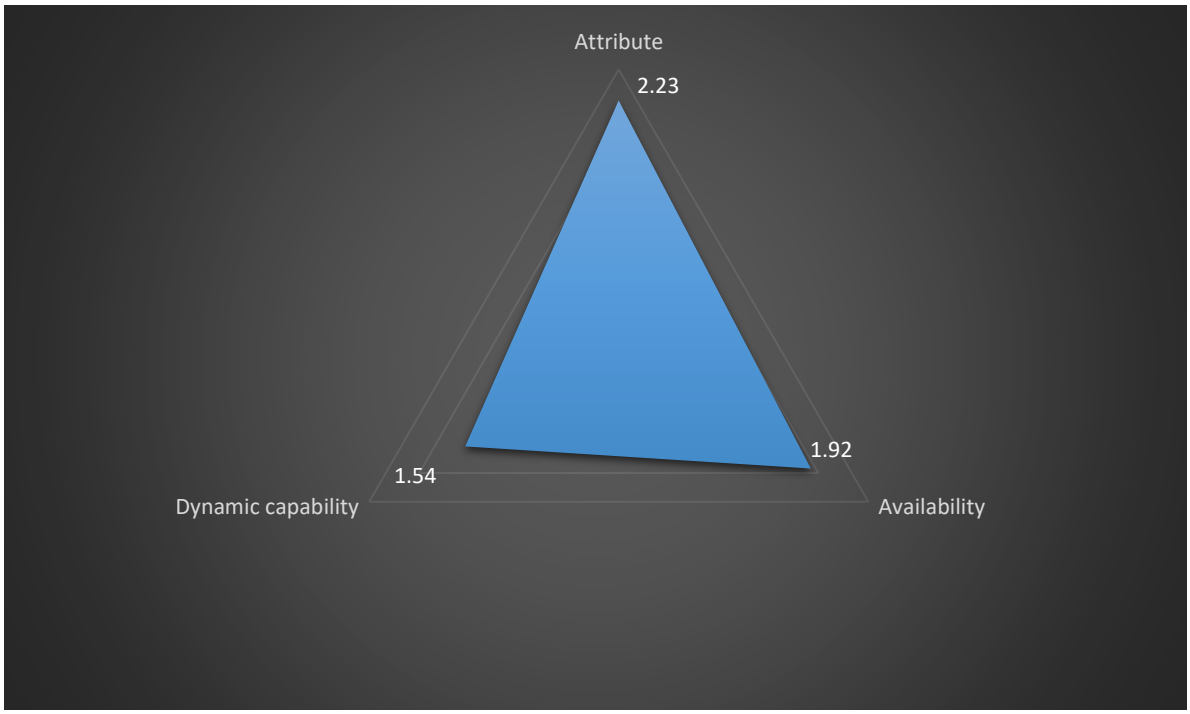

Figure 5-7 Resources capability level

5.4.8 Analysis

Areas to Focus and Next Steps

Based on the survey results and the interview feedbacks these are some core areas to focus on in order to improve the innovation capability of the organisation as shown in figure 5-8.

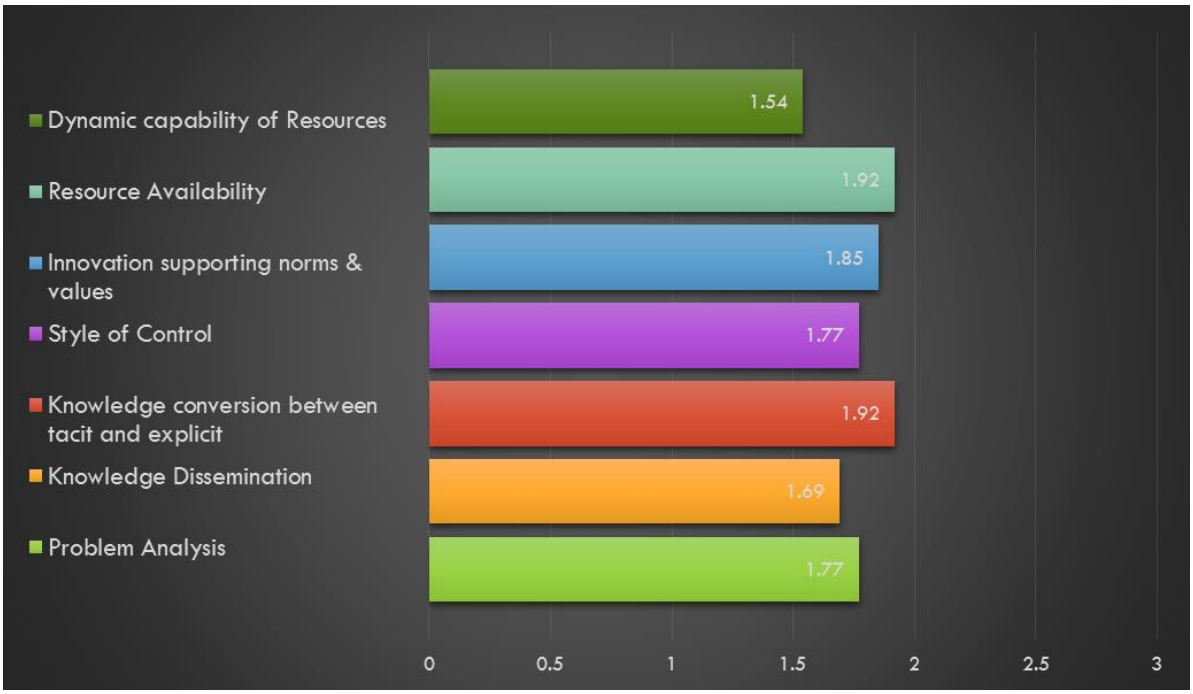

Figure 5-8 Areas to focus based on innovation capability level

The innovation capability model suggests the following steps to improve the innovation capability level in Air NZ. The model suggestions need to be incorporated with interview feedback and current company initiatives in order to come up with a strategy for making a truly innovative organisation.

Innovation process:

- Defining the problems clearly and conduct systematic analysis of root causes
- Use a standard problem solving tool that fits the organisation
- Define solutions with a holistic or systems perspective
- Formal training in established problem solving methodologies
- Share the best practices and methods to other parts of the organisation
- Encourage high level of internal participation and people with diverse skills
- Nurture a culture of open communication and engagement
- Continual improvement approach to projects and encouraging learning from previous success and failure

Knowledge Management:

- Continuously develop and expand internal knowledge base
- Effective use of processes for collaboration and knowledge sharing
- Tools and platform for internal and external collaboration
- Continually develop internal and external collaboration
- Encourage knowledge sharing and collaboration and have organisational incentives
- Understanding of knowledge conversion between tacit and explicit
- Proactive and dynamic response to new information

Culture:

- Encourage experimentation and having tolerance for mistakes
- Embrace new ideas and foster learning from failures
- Consider creativity and risk taking as desirable and normal
- Provide time and resources for working on new ideas
- Have flexible styles of leadership, transformational at the early stages of innovation and transactional at the later stages
- Develop an organic, flexible and externally focused cultural orientation

Structure:

- Actively seek external sources of ideas and resources and share with other firms
- Increase network ties with industry partners and build collaborative relationships
- Systems and processes in place to address negative issues arising from increased organisational complexity

Control:

- Having a control style which is flexible and dynamic; interactive style for uncertain stages of innovation and diagnostic style for latter stages
- Mechanisms in place to encourage flexibility and creativity
- Empowering mid-management level and allowing for managers to exercise autonomy and discretion
- Establish self-managing teams for innovation operating in line with strategic directions of the organisation

Resources:

- Focus on acquiring resources and capabilities to fit with and be complementary to existing resources
- Efficient and disciplined use of resources to create enough slack for innovation
- Strategic and planned approach to selection and acquisition of new resources and capabilities

5.4.9 Innovation Practices in Air NZ

Air New Zealand is an example of company that has been able to strike a good balance from a marketing and a services standpoint (Air NZ.2020). When it comes to customer experience the airline is renowned as one of the world's most forward thinking and tech-savvy. However, there are untapped opportunities in back end operations which if addressed correctly could add another level of competitive advantage.

The airline has proved its ability to innovate and come up with unique solutions. One example is safety videos which are creative and innovative and shows the airline's willingness to question the way things are done. Skycouch is another example of customer focused innovation at Air NZ. Self-service kiosks for domestic flights are introduced in 2006 and later extended to all flights. Another example is the automated, biometric bag drop which is aimed at enriching customer experience and save time. Employees were empowered and encouraged to explore, prototype, test and iterate on even the most unconventional ideas. Openness to try out new ideas and a structured prototyping environment were some of the factors which helped the above innovations.

The airline has adopted a strategy of being a follower on areas which are less visible to the customer. There are several pockets of innovation at different areas of Engineering and Maintenance at Air NZ. E-log project has been implemented while 3D printing, mobility and predictive analytics are some other areas under development. In recent years there has been an increase in the diversity of resources and collaboration with universities and other supply chain partners. CAMO project in Air NZ is an example of a collaborative project which is geared towards setting up the foundations of process and systems knowledge in the organisation.

CAMO Project

CAMO project is a performance based approach to continuing airworthiness. It is a management system driving the right behaviour based on building quality into the system. CAMO has effectively built the business frameworks to support the work of engineers. It has the intention to change the

functional environment from static engineering groups to that of a performance based environment further advancing safety and commercial success of Air NZ.

CAMO project in Air NZ has prepared the surface for accepting changes and a better environment for knowledge sharing and collaboration. It has also integrated the safety, operational efficiency and commercial aspects under a balanced framework. One learning from CAMO on enabling diversity of thought is to have equal representation from the three generational groups and providing an agile and healthy atmosphere for sharing knowledge.

Engagement and positive enablers in CAMO project:

- Clear message by the leadership
- Intrinsic motivation by showing the pain points
- Using generational diversity effectively for change management
- Tailoring the messages and targeting to six different competencies
- Finding skilled resources from the organisation

E-Log Project

Electronic Log project at Air NZ followed the e-enablement project and the knowledge gained from the previous project helped the team formation and project execution. The team consisted of people from many streams including Flight Operations, Pilots, Cabin Crew, Engineering, Maintenance, Digital, Quality and Safety. This project is a good example of the wider Air New Zealand team working together to introduce modern processes into operations.

E-Log project teams' site visits to validate the project approach and learn from other airlines' experience and proactively working with CAA NZ and the OEM on the project are good examples of collaboration. Close interaction with Boeing including mutual visits and technical coordination meetings helped with providing user feedback in the successful project outcome. The project has contributed to the learning curve of the team members as well as the organisation. It has also helped put in disciplines and structure for future projects and the team members have gained more confidence to undertake similar projects in future.

Project success factors:

- Had a professional project manager
- Business analyst played a key role in putting ideas into processes
- Each stream leads come up with the use cases
- There was a rhythm to the project with meetings, conference calls and workshops

- Had a good leader or champion to drive the project
- Support and confidence provided by the upper management
- Boeing having a definite plan of going live with E-log for B789 and Air NZ being the first customer
- Close interaction with Boeing including mutual visits and technical coordination meetings
- Air NZ joined the E-log working group
- Visit by KLM and SAS which helped with mutual learning
- Visited KLM, Virgin Atlantic and British Airways to learn the best possible approach
- Complementary learning by airlines (e-enablement, e-log), by Boeing (user feedback) and Air NZ (suggestions for better user experience)
- Early engagement and coordinated approach from stream lead while interacting with NZCAA

5.4.10 Management Initiatives at Air NZ

The study of innovation capability will be incomplete without understanding the different management initiatives at Air NZ. Some of these initiatives are specific to AEP but there are other corporate level initiatives which have a stake on AEP in driving business planning, prioritising, people engagement and process improvement. These initiatives have the potential to fundamentally influence change management and enable collaboration and learning which are key innovation fundamentals.

Performance Insights

Performance insights is one of the most forward looking initiative at AEP division in Air NZ. It was formed with focus on analytics, research & reviews and project delivery streams and later transformed itself into streams of analytics and operations & strategy. The motivational factors behind the group is to build analytics capability and to create analytical products to enhance decision making in AEP. There are several learnings from this initiative which are organisational best practices and could be adopted by other business units

One learning is about collaboratively working with other business groups in AEP and also with digital, information & analytics and business transformation groups. The group's communication

plans, agile way of project management and the change management approach are good learning for other business units in Air NZ. Unlocking the value as early as possible and effective communication with stakeholders are some of the factors that enabled successful change management. Look In, Look Out and Look Forward is a simple and elegant approach for business problem solving and this can be a good model to emulate for other business groups.

Aircraft Maintenance: Business Transformation & Improvements

The business transformation and improvement group under the aircraft maintenance was formed after integrating the various performance initiatives at Air NZ Christchurch and Auckland facilities. The 'Crusade' initiative, mobility group, web applications and tooling innovations are some key projects of this group. Out of this the tooling innovations have been commercial success and made tangible performance contribution to the maintenance business. Mobility Group was created to investigate digital and mobility technologies and how they could be introduced to aircraft maintenance. They also introduced web applications that provide solutions to real business requirements within heavy maintenance in Christchurch.

Aircraft maintenance is one area where value addition and unique positioning could give a competitive advantage to Air NZ. Christchurch could act as an innovation hub and some of the ideas could definitely improve efficiency and productivity in the firm. It is important to maintain the innovative culture in maintenance and also execute any viable business solutions developed by the business transformation group. Given the proper management structure and support this group has the potential for breakthrough innovations.

High Performance Engagement (HPE)

High Performance Engagement is about working together collaboratively to achieve mutually beneficial outcomes, such as operational business improvements. It is a way of working where people closest to business issues are involved in helping identify and develop solutions for those issues. HPE is not a set of tools or complicated processes, but rather a mindset where people across the airline should be thinking "*How can I involve people before coming to a solution?*" To achieve this collaborative state, it needs to be built into the culture and practices of a company and become part of its DNA.

The main drivers of HPE are the following:

1. Higher staff engagement
2. Productivity improvements

3. Stronger results

At the core, HPE is about working collaboratively and tapping into the knowledge and skills of all employees instead of just management. It is also about collaborative decision making with a more inclusive approach. Open reasoning and having a wider diversity of thought are some of the positive traits of HPE.

HPE involves using analytical continuous improvement tools such as Lean 6 Sigma and Kaizen, or interest-based problem solving. The Continuous Improvement team will be supporting and training people on using these tools. There are plans in place to come up with HPE 2.0 considering the future vision of the firm.

Continuous Improvement (CI)

The Business Performance Group in Air NZ handles the continuous improvement projects. They can play a huge role in creating a change mind set and encourage incremental innovation. In the case of Air NZ, operational excellence is equally important as customer experience and the two are interrelated. An example for this is On Time Performance (OTP) which is a key performance indicator for the airlines and is directly linked with customer experience.

The Continuous Improvement team works with other teams and is in alignment with the HPE initiatives at Air NZ. They are developing an operational excellence framework in line with the organisation best practices of successful international firms. The team has to balance between operational priorities and are preparing to face future challenges. The approach taken by the CI team is to 'complement and align' with other organisational initiatives.

Go Beyond

Go Beyond is Air NZ strategy framework which was first defined in 2013. It is a framework used to express Air New Zealand's purpose, customer promise, and long-term objectives. The strategy says: "Our purpose is to supercharge New Zealand's success, economically, socially and environmentally. This is about making a positive impact on our broader society, creating sustainable growth, and contributing to the success of New Zealand's goals".

The focus areas are:

1. Customers at the Core
2. Expand the Travel Experience
3. Execute the Plan
4. Fighting Fit

5. Winning Team

Innovation is not explicitly stated in the strategy document. But it is built in within the main drivers. The Airline's guiding principle says, "we will build competitive advantage in all of our businesses through the creativity and innovation of our people". But this approach is hard to find in the day to day operations of the airline and in its strategic planning process. This core principle needs to be explicitly stated in the strategy and be a guiding principle in the business planning process.

One of the main Go Beyond element is customer focus and it says: "Put customers at the heart of everything we do." But not all business units have the same visibility for customer experience and understand how innovative projects are making a change to the end customer. In a big organisation like Air NZ it is easy to lose focus of the end customer and thereby lose the perception of value chain. Each and every business function is connected and is part of a value chain which connects them to the end customer. It will be a huge motivational factor when employees are able to identify the link with the end customer and see themselves as part of a bigger value chain.

5.4.11 Innovation: Ideas & Discussion

Airline industry clearly shows a trend towards productivity improvement through automation and better technology. New aircraft will have better fuel efficiency and safety features, improved data analytics capability, communications to the ground and in-flight information transfer between aircraft and the ground. Aircraft maintenance will see more use of robotics, drone technology, mobile mechanic digital assistance, predictive maintenance, wearable devices, and 3 D printing. Innovation in aircraft is going to see a rapid and exponential progress in alignment with the advancement of technologies in other sectors. There will be huge opportunities for airline operators to take advantage of this progress (Stief, Eidhoff, & Voeth, 2016).

"Aircraft maintenance requires cost competency and something to differentiate us from the competitors. We have high cost and hence there is a need to show difference in terms of service quality and better engagement with customers. Innovation has to be thought in this sense of offering better value to customers."

Technology change is exponential and we make the mistake of plotting a linear trend of change. The new technologies will increase the reliability of processes and improve operational efficiency and productivity. The time has come when the labour costs are reaching a limiting stage and process

automation using digitization, robotics and other ways of supplementing human labour is a logical step of improving efficiency and reducing cost in the sector. Small airlines can be fast adopters of technology but there is little option in not participating in the technology change which is happening in the industry.

Regulation Vs Bureaucracy

Organisations are sometimes crippled with bureaucracy, and it will slow down innovation and growth. The people who are working in the organisation for a long time may not realise the slow creep of bureaucracy into different areas of work. It may be in the form of new systems in place to prevent one off happening or it may be due to over processing of regulations. Regulation has a role in creating the bureaucracy by putting in more layers of control as incidences happen. The time to execute a new process change to generate positive results have an important effect on successful innovation. If there are several bureaucratic layers which slows down the process it will affect the motivation of people who are leading the effort.

In the case of Air NZ, it can be argued that it is the bureaucracy which is slowing down change process. Regulation may have an effect, but it is usually used as an excuse to not try new ways of doing things. Long tenure and lack of outside industry experience have created a tough culture within the organisation. One implication is that it becomes difficult for new hires to fit into the organisation and ultimately, they adjust to the new normal. Bureaucracy is contagious and it will slow down those who are coming up with a change mind set.

Innovation Strategy

Instead of giving all the answers it is more valuable to generate a positive thought process and conversation on innovation strategy. These questions will help to create an innovation roadmap for AEP and make it sustainable over time.

1. What level of innovation capability the firm is willing to aim for?
2. How to create an ‘innovation democracy’ where ideas can come from anyone in the firm and innovation becomes embed in the company culture?
3. How much percentage of discretionary time can employees and managers dedicate to innovative projects?
4. What can be done so that employees see innovation as part of their job?
5. How to spread the innovation responsibility through every level of the organisation and involve everyone in the firm?
6. How to free up more time, energy and brainpower to devote to innovation projects?

7. How to create a management structure to avoid side-tracking innovation projects?
8. Does the organisation have an “immune system” which tends to attack new ideas?
9. How to use the collective creativity of all employees on the job?
10. Does the firm have programs for teaching people the tools of innovation?
11. Is it possible to dedicate percentage of manager’s time to mentor innovators?
12. How to change the cultural mind set and create norms, values and behaviour to encourage creativity and innovation?

5.4.12 Interactions and Innovation Ecosystem

E-log digital innovation project, university student teams, exchange students from Europe were some of the external interactions that happened at the Air NZ. Executives higher up in the corporate ladder were involved in the innovation capability study and had a positive impact on the overall exchange of knowledge. Regular updates and meetings with the project supervisor were conducted to plan the organisational interventions to improve innovation learning.

E-log project team was very diverse and composed of highly skilled people from different parts of the organisation. Close association and collaborative innovation with the supplier Boeing and the software application provider had a major impact on the overall project. Both those firms were highly innovative and the interactions helped in transferring innovation best practices. Visit by other airlines like KLM and SAS helped with mutual learning and collaboration. Air NZ in return visited KLM, Virgin Atlantic and British Airways to learn the best possible approach for the digital roadmap. The role of ‘collaboration champions’ is also to be mentioned. It is for the benefit of the organisation to have people who are good in maintaining and nurturing external links.

University project involved students from the University of Auckland taking the course ‘Technology Management’ which requires industry projects. Air NZ was very receptive of taking student projects and the projects involved testing out some of the new technologies in order to improve airline capability. Projects on 3D printing of airline parts and paperless aircraft operations were done as part of this university-industry collaboration. Fresh ideas from the students as well as the dynamic capability of the airline helped with both the projects. There is empirical evidence of this external collaboration changing the internal collaboration dynamics as well as the internal knowledge sharing at the Air NZ. The student team acted as a mean for several managers to openly share their ideas and think innovatively.

Air NZ also have a program in which students from Europe are taken in for a yearlong project, mostly involving future focused ones. This has definitely helped the firm in changing the internal culture

due to the external interactions with exchange students. It was also good to see the diversity of the firm increasing because of young people. Air NZ also employ people from other nations and this brings in highly skilled expertise as well as help in changing the traditional company culture.

5.4.13 Recommendations

Air NZ's guiding principle says, "we will build competitive advantage in all of our businesses through the creativity and innovation of our people". The recommendations are aimed at recognising the ongoing innovations and to provide a roadmap for continued innovation at Airline Engineering and Planning. Innovation needs to be viewed as a marathon rather than a sprint and requires a holistic view to address the fundamental factors. At the same time 'over-engineering' can negatively affect the creative process. Hence recommendations are put under different themes which will help to create a thought process to derive the best way forward for AEP.

Improve Knowledge Sharing

Knowledge sharing within the organisation and also with supply chain partners will help to keep the innovation relevant and sustainable (Odenthal et al., 2004).

- Encourage knowledge sharing from experts or teams within the firm and also external to the firm.
- Make it easier for employees to find resources online and make avenues to share ideas and out of the box thinking.
- Share innovation case studies, best practices and methods to other parts of the organisation.
- Create enablers for active use of online platforms and tools for knowledge sharing.

Increase diversity of thought

Diversity will fuel innovation (Skarzynski & Gibson, 2008). New voices are essential for new thinking and diverse teams have a better chance of coming up with fresh new answers.

- Encourage and facilitate diversity in all forms including gender, academic, cultural and generational.
- Give more opportunities to young people and newcomers to the company.
- Leverage experience with new ideas and knowledge to form smart creative teams.
- Bring in voices from outside the organisation and outside the industry.
- Increase the diversity and talent pool of resources.
- Encourage 'creative collision' through connectivity and conversations.

Empower employees by providing innovation leadership

Innovation needs better recognition and managers need to be empowered to create space for creative problem solving and new ways of approaching problem solving.

- Create effective incentives for managers to continuously support innovation rather than defaulting to a risk-averse approach.
- Empower mid-management level and allow managers to exercise autonomy and discretion.
- Implement flexible styles of leadership, transformational at the early stages of innovation and transactional at the later stages.
- Provide formal training in established innovation and problem solving methodologies including Design Thinking.
- Foster innovation through effective coordination between management initiatives.
- Provide a new management structure to take innovation ideas to execution.

Increase internal and external collaboration and engagement

Partnerships and collaboration are key to promote innovation (Lee et al., 2012). There are clear rewards for this approach in terms of addressing the knowledge gap and time to market.

- Develop an organic, flexible and externally focused cultural orientation.
- Increase network ties with industry partners and build collaborative relationships.
- Create an online space for crowdsourcing of ideas and provide enablers for active engagement of the platform.
- Engage with OEMs, suppliers and other airlines to set up employee exchange training programs.

Extend Air New Zealand's success through collaborative innovation

Enabling external innovation becomes as important as improving one's own. Successful innovation ecosystems create virtuous cycles of external innovation partnerships which drives internal dynamics.

- Create a flexible framework to engage with smaller companies and start-ups and also partner with innovation hubs, universities and research labs for open collaboration.
- Emulate the success of customer centric innovation into business processes and back end operations.

- Develop an 'ecosystem mindset' with an understanding that new value and growth can come from beyond the firm.

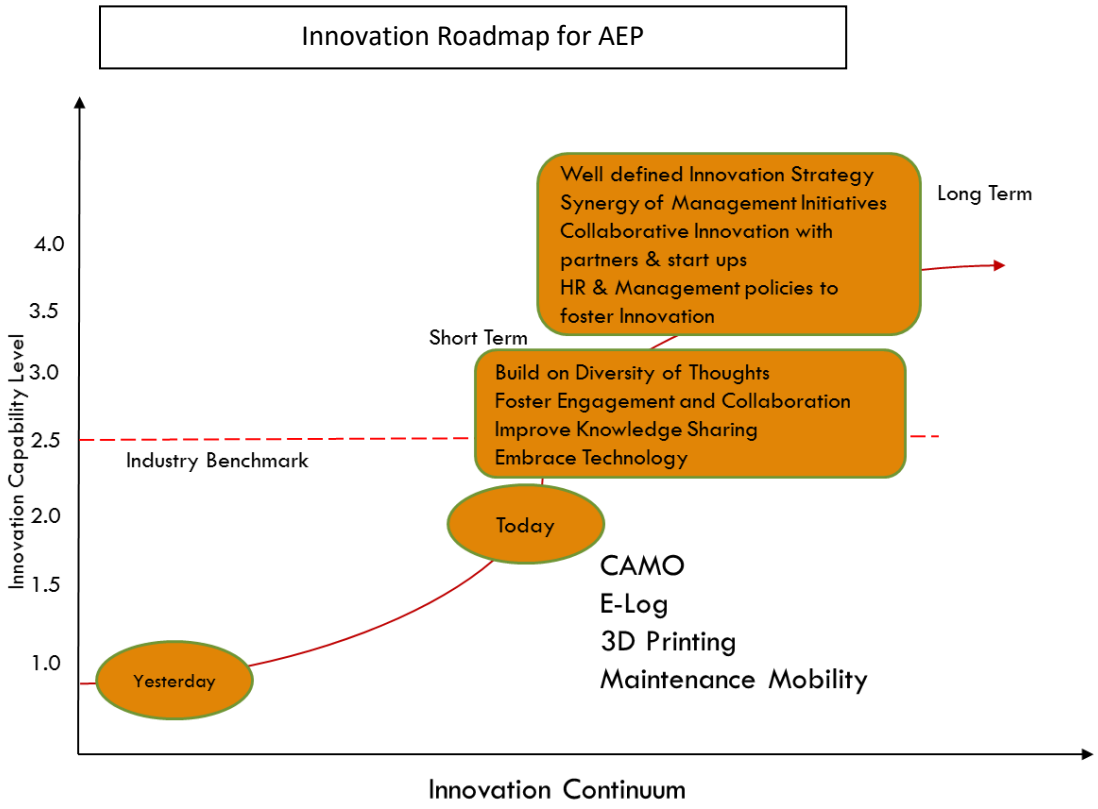

Figure 5-9 Innovation projection for AEP based on innovation capability level

5.4.14 Suggestions for future study and Conclusion

Possible next steps towards learning include innovation benchmarking with other firms to see where Air NZ stands in the innovation curve. This is shown in figure 5-9 above. Learning about innovation best practices in other firms and adopting elements of it within AEP can help develop an internal innovation eco system. Study of factors of collaboration and engaging in more collaborative initiatives with OEMs, suppliers, universities, research institutes and with other airline operators will help reduce the knowledge gap and boost innovation in Air NZ.

Technology is a crucial driver of innovation and Air NZ needs to embrace that fully. Use of technology to free up resources and enable employees to work on creative and market winning ideas is a logical step for an innovative organisation. Industry proven technology solutions could be adopted swiftly, and the technology induced process change will improve productivity and back end operations. This requires an organisation which is innovation ready and agile towards new knowledge and is capable of positively responding to new knowledge. An operating model is needed which combines digital technologies and operations capabilities in an integrated way to cut across organisational silos.

Customer perception and brand value is a clear competitive advantage for Air NZ. However, there are untapped opportunities in back end operations which if addressed correctly could add another level of competitive advantage. The airline needs to emulate the success of customer centric innovation into business processes and back end operations. This will in the long term provide unique competitive advantage for the airline as well as make Air NZ more efficient in all levels of airline operations.

5.5 Case Study 2 Ports of Auckland Ltd.

5.5.2 Introduction

Ports of Auckland is owned by Auckland Council, but operate independently. Nearly three-quarters of the inbound cargo for Auckland is handled by the port. The port also serves as a vital tourism hub and handle over 100 cruise ships annually. The port is on its ambitious journey of having New Zealand's first automated container terminal (Poal.2020).

The innovation capability study was designed to collect data from key stakeholders from different areas in Ports of Auckland Ltd. The case study research was done in collaboration with the innovation manager at the port with the active support and encouragement from the executive team. A total of 14 surveys were conducted which was followed by 20 face to face interactions and numerous meetings with the port management. A close study of the eMPX innovation project was also done as part of the case research.

5.5.3 Survey result

The survey results and the interview feedback are correlated in order to arrive at the core message that the study conveys. Areas to focus on are found by looking at the innovation capability score and the consistency in feedback from the survey attendees. The results show current levels of innovation capability for each parameter and specific areas to focus based on the score and the consistency of feedback. This is being combined with observational data on the eMPX innovation project and other innovation related activities at the firm. Various meetings with the executive team and observations done on the organisational initiatives provide greater insights into the innovation dynamics of the firm.

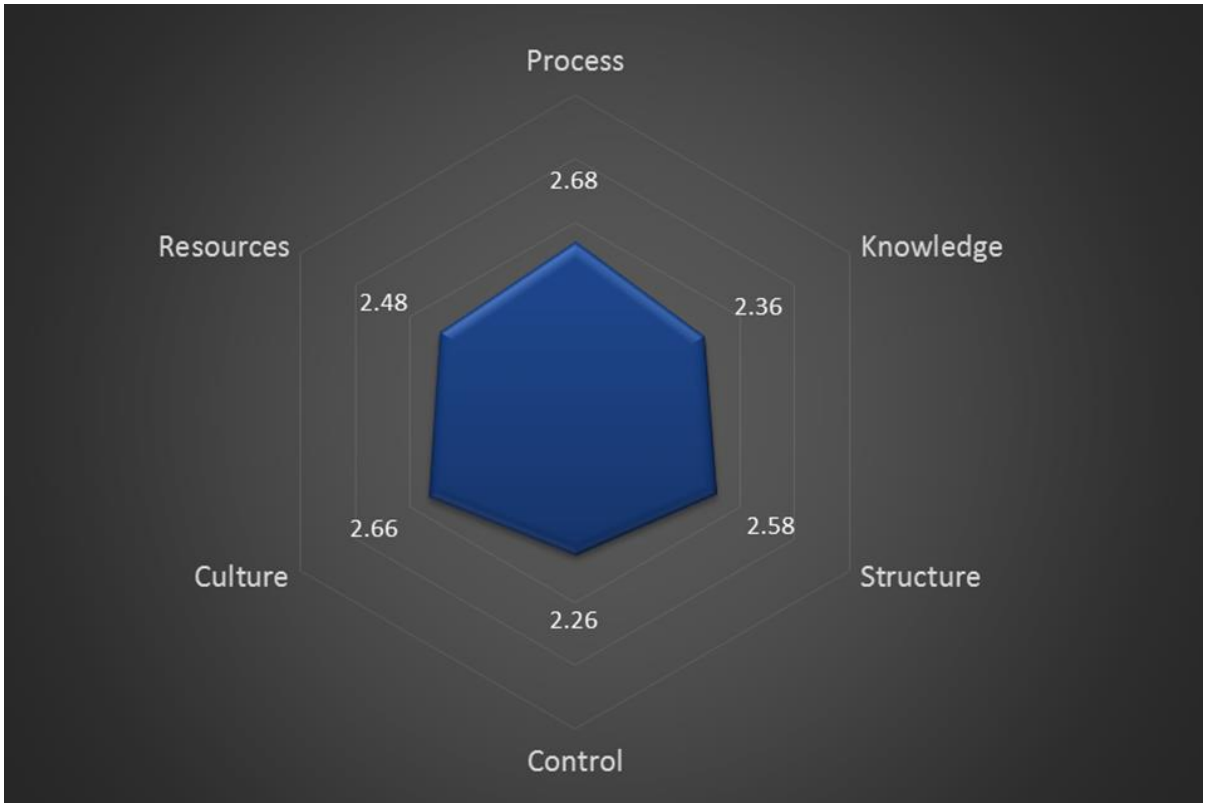

Figure 5-10 Organisation's Innovation capability level for each factor

According to the survey result, as shown in figure 5-10, the organisation has innovation capability level of 2 which implies that the overall level of innovation capability is 'Managed' according to the capability maturity model. This shows that the innovation processes are reactive and there is a huge opportunity for improvement in the innovation capability. These scores are indicative based on the capability maturity level and should not be considered as absolute values. When combined with interview feedback and other observational data it can give a good insight into the current state of innovation capability and areas to focus on.

5.5.4 Interview Feedback

Interviews provided a variable mixture of feedback on understanding the concept of innovation as well as on its impact on the participant's area of work. Perception on innovation differs with people and the scale and nature of the concept conveys different meaning to different people. The positive aspect is the general understanding and acceptance that innovation is becoming an important part of their vocabulary. Challenging the status quo, future focused, finding new ways to do things, discovering new possibilities, moving from reactive to proactive organisation were some of the definitions given by the participants. The missing factors were the value and customer perception.

"Competition is lacking in New Zealand industry and hence innovation or R&D is not a priority for Kiwi firms. Maintaining the status quo is killing innovation and productivity growth."

The main barriers for innovation according to the interview participants were the lack of resources. Finding resources in an operationally intensive organisation is a challenge. Having the right expertise and support for innovation is also lacking in the firm. Innovation hub is addressing some of these challenges but there is a need to spread the seeds of innovation across the organisation. Innovation team needs to develop a sustainable framework to take up innovation projects from different parts of the business. Lack of risk appetite, freeing up people's time and funds, barriers due to traditional nature of the business were some of the other key challenges cited by the participants.

"Never underestimate the power and intricacy of culture. Corporate culture is not only invisible for the (long term) insider, but also untouchable."

Relevant organisational changes are required for innovation to happen and some of these are related to culture, knowledge and control aspects. Prevalence of silos, traditional mind set, different personality types, lack of engagement and knowledge sharing etc. needs to be addressed before we can build an innovative culture in the firm. More avenues for knowledge sharing and collaboration is required. Organisation needs to look at ways to develop knowledge platforms and how to process new knowledge in the firm. Employee engagement activities needs a relook and steps needs to be taken to make it sustainable overtime. Collaboration within and outside the firm will bring in knowledge and at the same time will help create an ecosystem mindset.

"We are quite siloed. Industry is somewhat traditional. Can see that it is being recognised and changes are happening."

Better engagement, putting innovation at the center, bigger innovation team, more championing, breaking down silos, and identifying change management as a priority were some of the repeated feedbacks from interview participants. Encouragement for innovation at the executive level is sighted as a key game changer for the firm. If the top management gives the go ahead then things can happen. One other suggestion was to include innovation as an agenda item in team meetings. The need for democratising innovation and sowing the seeds of innovation throughout the organisation were pointed out during the interviews. Reward and recognition for innovation was discussed by many participants. Proper recognition, attending upskilling sessions, involvement in developing the idea, bonus based on financial returns, more percentage of time in innovative projects etc. were suggested.

What innovation takes: Voices from the survey

The following are comments, edited for length, from respondents to Innovation Capability interview.

"Innovation is any new concept that improves the way we do things. To the business it is the method by which the organisation delivers new and improved services to the customer and stakeholders."

"If you keep doing the same you will become redundant."

"In the last 3 to 5 years innovation has had a positive impact but challenging the conventions and status quo is still hard."

"People's understanding of innovation, what innovation means is different: some amazing new product, or a simple process change?"

"We need to recognise what we are good at and what we are not good at. We need others to challenge our thinking."

"As a unit we do things collaboratively. Not that frequently between units as it should be. There are business units which are stubborn."

"We don't have a knowledge champion, no CIO, no one in the board or execs dealing with knowledge sharing. Need to make knowledge a high priority, structure training etc."

"To find experts is easy but to get the information is not that easy because of time constraint. Hard to catch them."

"A dollar spent allowing worker participation at the front end of innovation is worth many more at the back end without participation and the pushback that entails."

"Some of the organisational engagement initiatives are not sustaining beyond a certain point."

"Collaboration: saying and doing are two very different things here, with little overlap."

"Innovation is not given the priority it requires, and the attention is being diverted by operations related functions."

"Automation can have an impact. Other jobs may be created, future state will be different. New skills are required."

"Clear structure of the innovation hub to be created. Formal process of how things work: how innovation happens, support with business plans, commercialisation process, IT help, piloting and prototyping help."

"Innovation team needs more autonomy. Corporate structure is not agile. Decision making needs to be fast."

"The aspiration level, culture and mindset have a bearing on the innovation and R&D spend by New Zealand firms."

"Encourage employees who are interested to become involved in and network in the external innovation environment, including through company-supported attendance at external workshops, conferences, demonstrations etc."

5.5.5 Key Findings

There are several practices in the industry which are shaped over several decades. Knowledge and expertise with different individuals at certain areas of the organisation are really valuable. Better collaboration and cross functional project teams could tap into the individual knowledge and encourage more sharing. This is one of the fundamental requirements for innovation or any other change management projects.

The main findings of the survey are:

Lack of Resources for innovation

Innovation takes place in an organisation when it brings together the right combination of talents, incentives and opportunities. Availability of resources in terms of time and funding are lacking in

the organisation. Innovation is currently practiced through individual 'sample' initiatives which use external resources and which do not affect internal resources. Innovation projects suffer when the resources are constrained or projects are being pursued with more traditional management structure. Development of a framework to take up innovation projects and a clear structure of innovation hub is needed.

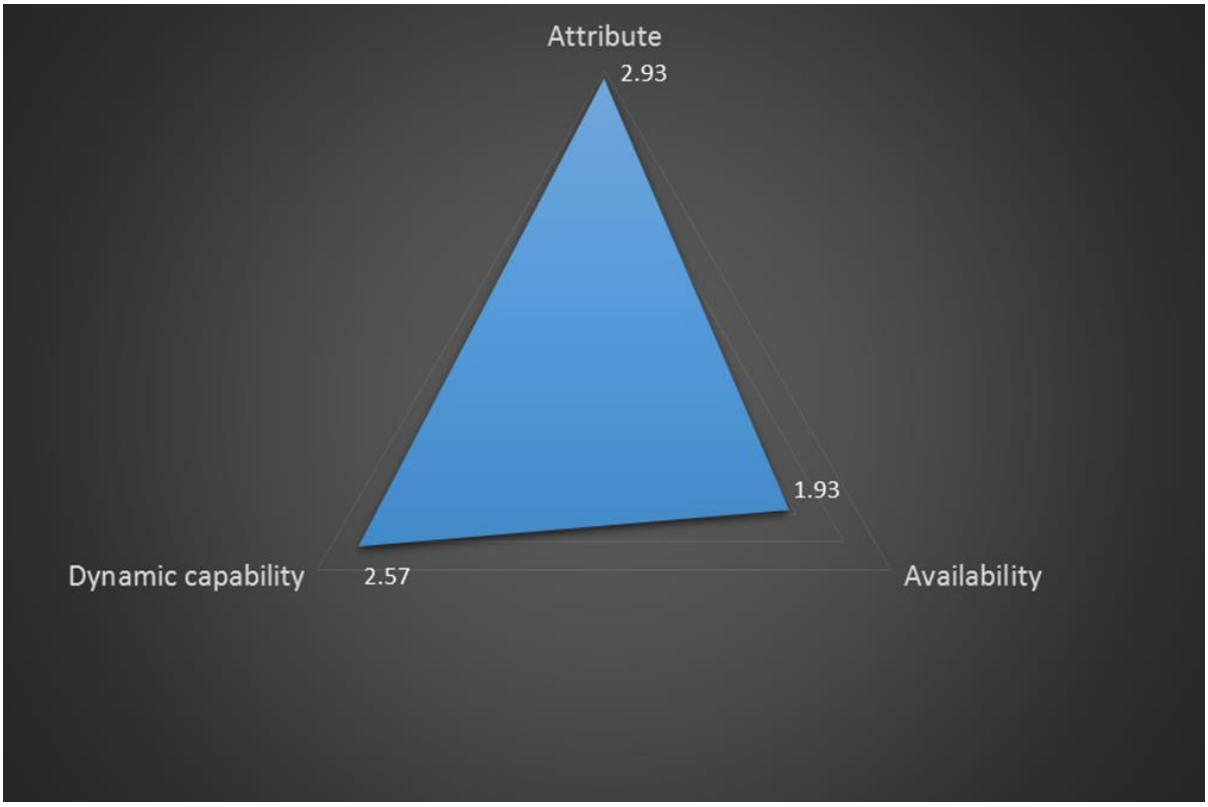

Figure 5-11 Resources capability level

Knowledge Management and Collaboration

Lack of platforms for knowledge sharing, lack of agility and positive response towards new knowledge are some of the main feedbacks. Bringing knowledge into the organisation and properly utilising the new knowledge for the firm's benefit could be improved. There is also scope for improvement in internal collaboration between different business units and proper dissemination of internal knowledge base.

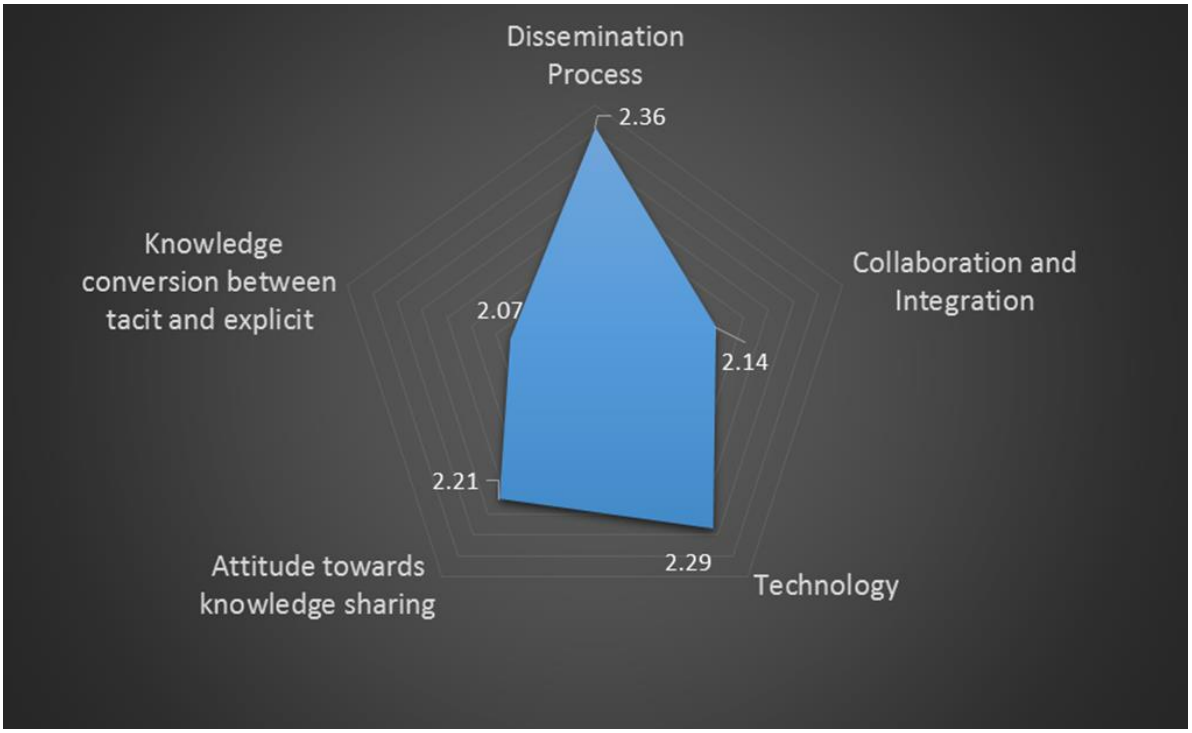

Figure 5-12 Knowledge Management capability level

Lack of Innovation supporting culture

It is important for the firm to see the value of long term benefits of creating a culture of innovation. There is a lot of scope for providing a culture of change and innovation supporting norms and values. Empowering mid-management to take decisions pertaining to innovation and providing flexible and dynamic control system at early stages of the innovation could encourage more innovative ideas to be pursued in the firm. Encourage experimentation, tolerance for mistakes, fostering learning from failures and encouraging creativity are some of the ways to nurture innovative culture. Innovation is at its core a problem solving process. Hence systematic and holistic way of problem analysis and use of best practice tools are essential elements to support innovation process. The below figures (figures 5-13, 5-14 and 5-15) show the current level in three important aspects in the innovation capability which in turn shows an opportunity for improving each factor.

"Culture, collaboration and knowledge sharing initiatives, all may trip over a fixed mindset."

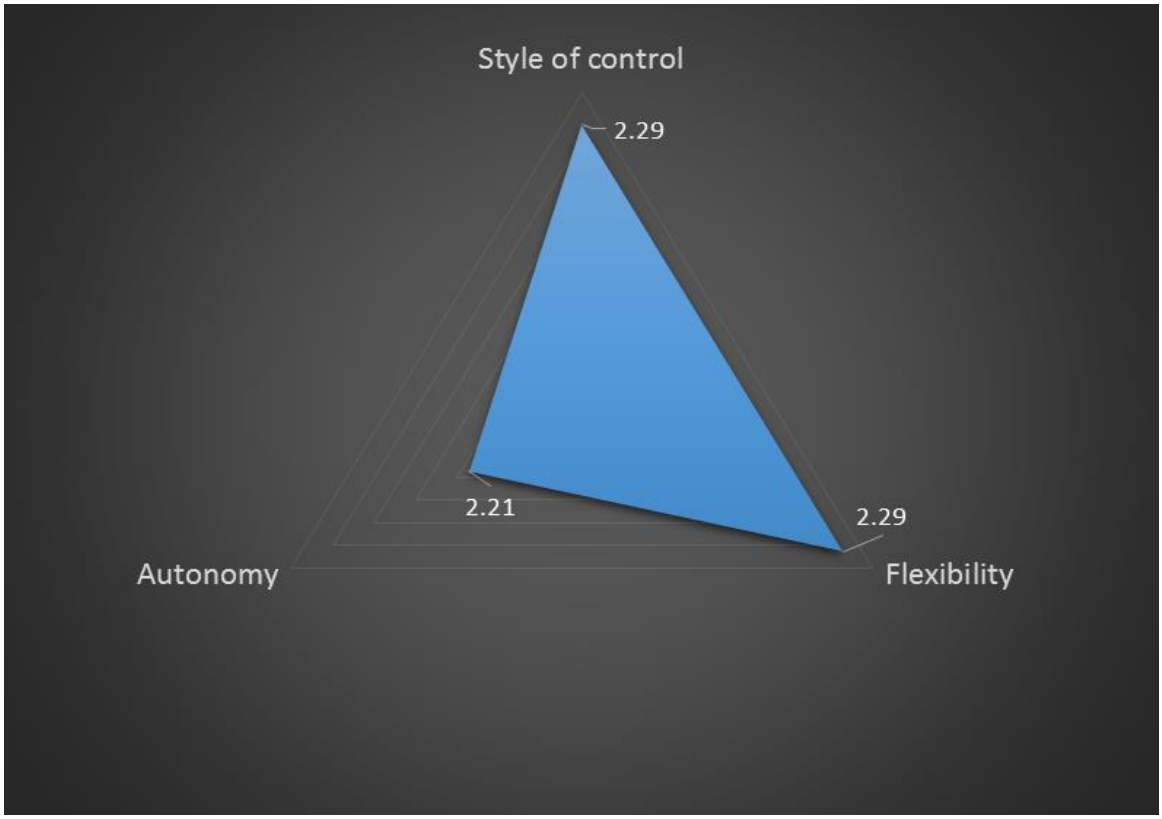

Figure 5-13 Control capability level

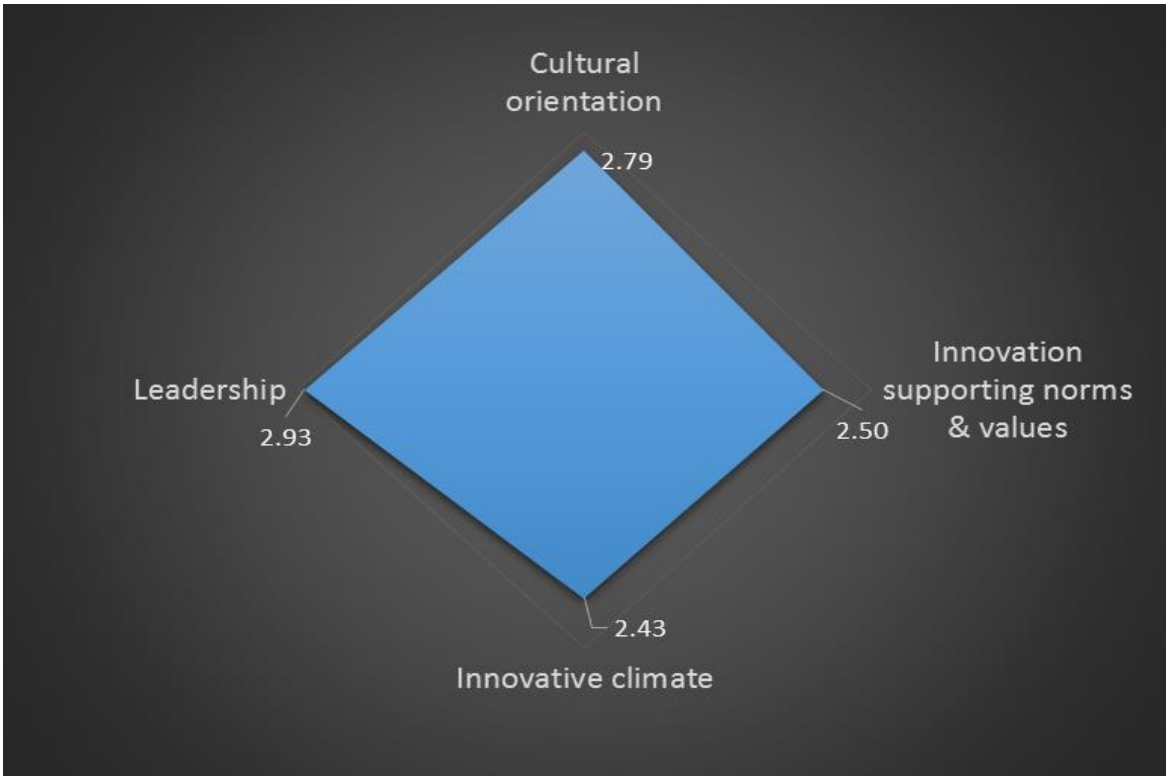

Figure 5-14 Culture capability level

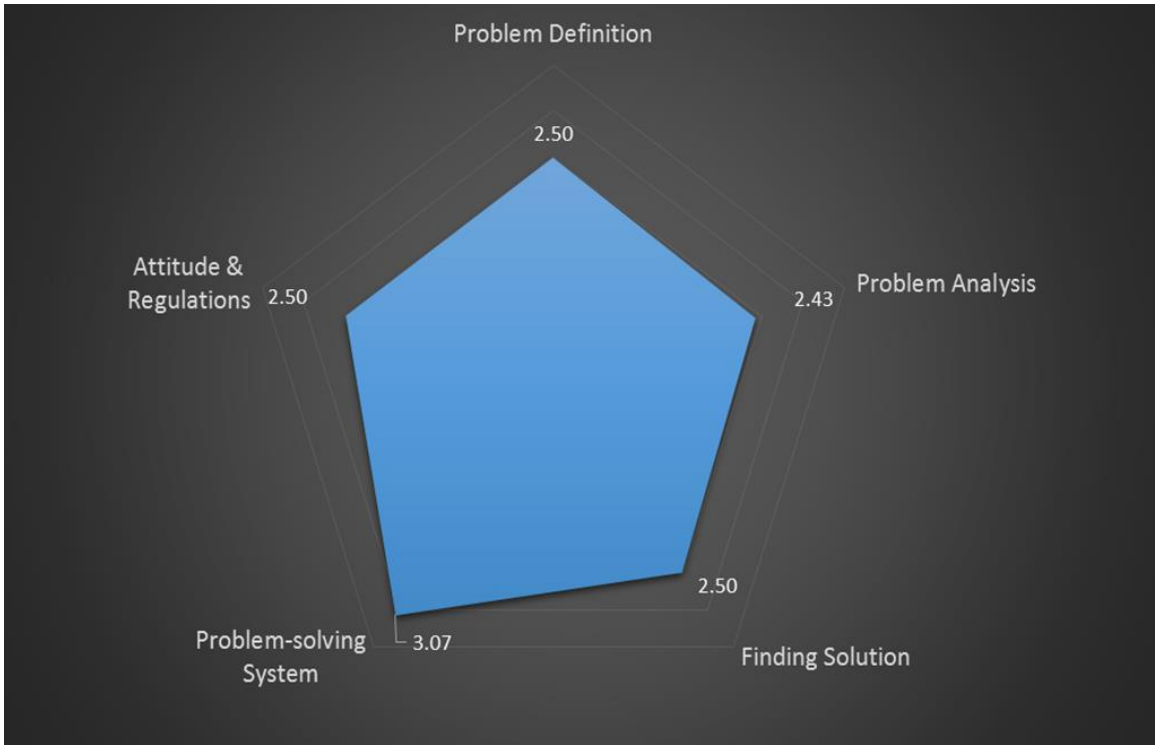

Figure 5-15 Innovation process capability level

5.5.6 Analysis

Areas to Focus and Next Steps

Based on the survey results and the interview feedbacks, figure 5-16 shows core areas to focus on in order to improve the innovation capability of the organisation.

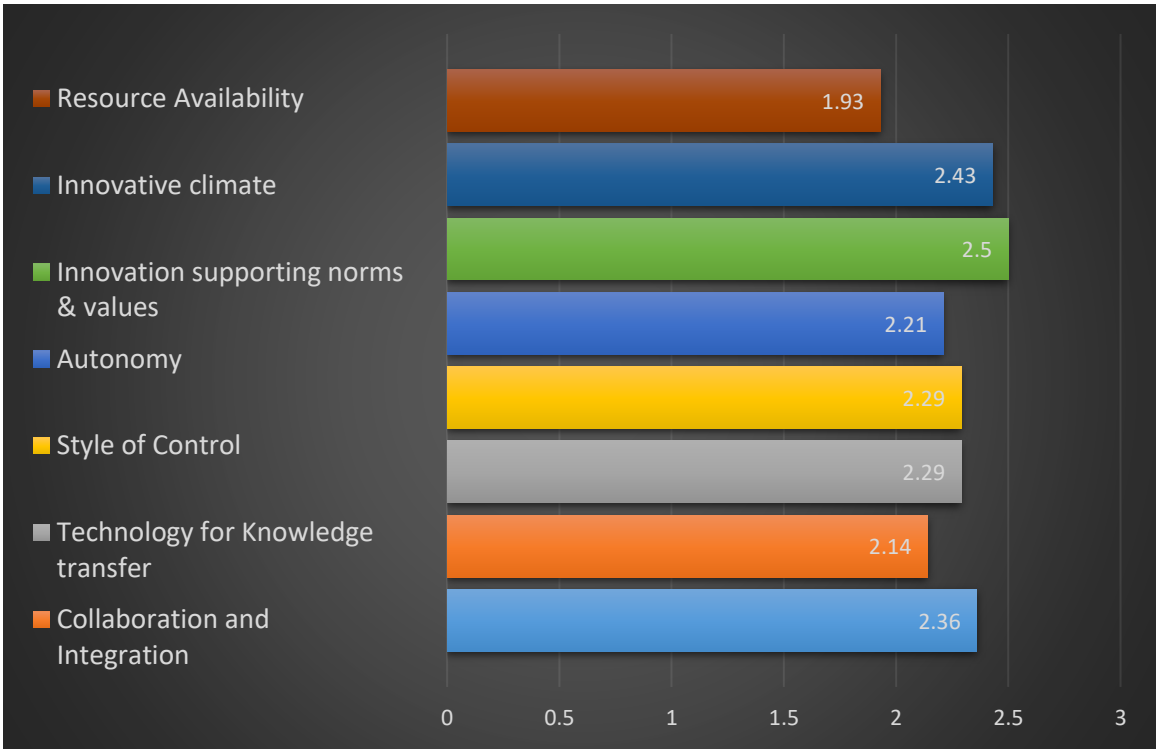

Figure 5-16 Areas to focus based on innovation capability level

The innovation capability model suggests the following steps to improve the innovation capability level in POAL. The model suggestions need to be incorporated with interview feedback and current company initiatives in order to come up with a strategy for making a truly innovative organisation.

Innovation process:

- Defining the problems clearly and conduct systematic root cause analysis
- Define solutions with a holistic or systems perspective
- Formal training in established problem solving methodologies
- Share the best practices and methods to other parts of the organisation
- Encourage high level of internal participation and people with diverse skills
- Nurture a culture of open communication and engagement
- Agile approach to organising tasks and resources

Knowledge Management:

- Structured process to scan for and acquire knowledge
- Continuously develop and expand internal knowledge base
- Effective use of processes for collaboration and knowledge sharing
- Tools and platform for internal and external collaboration
- Encourage knowledge sharing and collaboration and have organisational incentives
- Proactive and dynamic response to new information
- Knowledge sharing process is monitored for effectiveness

Culture:

- Encourage experimentation and having tolerance for mistakes
- Embrace new ideas and foster learning from failures
- Consider creativity and risk taking as desirable and normal
- Provide time and resources for working on new ideas
- Have flexible styles of leadership, transformational at the early stages of innovation and transactional at the later stages
- Develop an organic, flexible and externally focused cultural orientation

Structure:

- Actively seek external sources of ideas and resources and share with other firms
- Increase network ties with industry partners and build collaborative relationships
- Flexible structures with the ability to be rigid when appropriate

Control:

- Having a control style which is flexible and dynamic; interactive style for uncertain stages of innovation and diagnostic style for latter stages
- Mechanisms in place to encourage flexibility and creativity
- Empowering mid-management level and allowing for managers to exercise autonomy and discretion
- Establish self-managing teams for innovation operating in line with strategic directions of the organisation

Resources:

- Focus on acquiring resources and capabilities to fit with and be complementary to existing resources
- Appropriate management of slack resources to foster experimentation and risk-taking
- Strategic and planned approach to selection and acquisition of new resources and capabilities

5.5.7 Innovation: Ideas & Discussion

Right conditions for Innovation

Developing a learning culture in the organisation, empowering the employees to come up with innovative solutions, developing managers to support the innovation of others and improving employee participation in decision making are some steps which can lay the foundation for developing a culture of innovation in an organisation. An internal culture of openness and sharing makes successful collaboration and innovation possible (Chesbrough et al., 2006). This needs to be supported by having an appropriate reward system for innovation, allowing risk-taking, and benchmarking against best practices and industry leaders.

"Number 8 wire mentality is a good and bad at the same time. It kills cooperation."

Innovation strategy has to be defined at the highest level and the execution is to be done from the ground up and in alignment with the organisation strategy. The innovation message needs to be delivered to all levels of the organisation, along with ways employees can make innovation a part of their everyday activities. Innovation does work if the firm is prepared to make innovation an enterprise capability. Making such a profound cultural change requires time, money and

commitment. It takes an organisation 3 to 5 years to build the kinds of skills, tools, management processes, metrics, values and IT systems that are required to support organisation wide innovation.

The three preconditions for making breakthroughs happen as per Skarzynski and Gibson (2008) are:

1. Creating time and space in people's lives for reflection, ideation and experimentation.
2. Maximising the diversity of thinking that innovation requires.
3. Fostering connection and conversation – to serve as a breeding ground for breakthrough ideas.

Innovation Eco system

Creating an innovation eco system within an organisation can be done by borrowing some characteristics from other successful innovation hubs. Silicon Valley is a good example of it and has consistently produced breakthrough technology innovation and has a habit of doing it multiple times over several decades. There are certain components which makes it comparatively easier for innovation to happen in this area. Firms like 3M, GE, Johnson & Johnson, Google, Intuit and others have been successful in creating an innovation eco system within their corporate structure. Some of the common factors are availability of talent, space for innovation, ideas taken into completion, culture of knowledge sharing, collaboration and an environment which nurture fresh thinking. The recipe can be a little different but each organisation can find what works for them and create their own innovation eco system.

Intrapreneurship

Intrapreneurial leaders are an asset to any organisation and they have many traits common to entrepreneurs. One tangible recommendation for POAL is to develop and encourage intrapreneurship in an active way in the organisation. This will give more independence for creative people and also help problem solving in an effective way. This step will be key in developing an internal innovation eco system. The intrapreneurial leaders by nature are better collaborators and open to outside partnership and sharing of knowledge. This will create a more dynamic atmosphere in the firm and make it more innovative.

Internal crowdsourcing

There is a clear connection between employee engagement and innovation. Engaged employees are more creative and more willing to accept innovative ideas from others according to studies done by experts. Internal crowdsourcing platforms can channel ideas and expertise of the

company's own employees. This will generate a healthy competitive spirit in the firm and also help generate a thought process. Putting a relevant problem in the shared space and encourage people to suggest solutions is also possible. This can be done in an online platform with an offline workshop session to provide hands on approach.

Innovation Fear

There is always a fear that technology will take away human jobs. It has happened in other industries before. But if you look at the entire spectrum of technology changes starting with the industrial revolution it has resulted in more job creation. The people who have lost their jobs in each technology cycles have upskilled themselves, are freed up to do other things and have fulfilling lives.

Technology will always be an enabler and it will enhance the human experience. Some jobs are not going to become obsolete overnight but they are going to become obsolete in stages. Managing this transition is going to be challenging for organisations but it can be done in a smart and empathetic way. Companies need to start thinking about people they empower rather than people they employ. Innovation has to continue and it will transform processes and make it more effective.

5.5.8 eMPX innovation project in POAL

eMPX is an innovation project at the POAL which is a digital solution to improve control and quality of the planning and information exchange between pilot and master regarding the pilotage plan. Pilots are the users of the product and also the ships captains to a lesser extent. The port and internal stakeholders were keen to go for the commercialisation. The method and approach were about 'learning by doing' since it was the first innovation project undertaken by the port. The purpose was to commercialise profitably, learn from the experience and repeat the process for other innovation projects.

Organisational framework (organisational structure, culture etc.) was not ready for these kind of initiatives but some freedom was given to progress this experiment. The initiative was kept as separate as possible from the rest of the business as not to be distracted by daily operations and status quo project management. Executive support and buy in from the CEO and board were very crucial for the project. The project had a small team of motivated people who could handle the uncertainty and with diversity of skills, insights and experiences.

eMPX project went live after more than 2.5 years of challenging work and is an excellent example of the work done by the innovation team. It also helped to create an innovation process and close various gaps in taking an idea to successful commercialisation stage. The market prospect of eMPX

is good and a great example for POAL to see the opportunity being captured and realised successfully.

eMPX is not the only initiative supported by the innovation team over the past 2 years. Many achievements had a lower profile than eMPX. Innovation and the ability to keep up with changes and learnings from them is essential to creating a profitable path forward for POAL in the long-term.

Learnings from the project

Innovation Strategy: Work was done on developing a coherent innovation strategy. For innovation initiatives to succeed and reach their potential a well-articulated and shared innovation strategy is needed.

Collaboration: A lot of work went into collaborative initiatives within POAL as well as with start-ups, other businesses and universities. Worked on developing a 'collaborative innovation ecosystem'.

Process: Much of the potential and the ultimate result of the initiatives is determined by the processes. The innovation team developed a Front-End of Innovation (FEI) process for POAL. This covers strategy, ideation and concept development up to the business case. The aim of this process is to increase the success rate as well as the impact of the initiatives.

Innovation Capability: A lot of work has gone into improving the innovation capability of the firm. These initiatives focussed on values, purpose, mindset, tools and frameworks.

Projects: Innovation is not limited to capital intensive initiatives. Not all innovation requires large budgets, many relate to small but impactful changes to the business. A framework was developed with an aim is to ensure maximum opportunity and impact.

Decision making: Two factors were critical to the success of eMPX. Decisions were made independently from the current business (Marine, pilots and ICT). The decision not to proceed with the previous developer was an important one for the success of the project.

Commercialisation: There were two critical factors in the commercialisation of eMPX namely scalability and desirability. Both of them benefitted from a level of independence.

The learnings for the business from eMPX and other initiatives will add value to future innovations at the port and its ecosystem. Innovation is also more important than ever for the organisation in a changing environment.

5.5.9 Interactions and Innovation Ecosystem

eMPX innovation project and participation of university students in future oriented projects shows the collaboration and knowledge sharing side of the interactions with the immediate innovation ecosystem. Innovation manager and the researcher were involved in rolling out 'innovation hour' where employees got the opportunity to come up with ideas and brainstorm as well as train them in some innovation methodologies including 'Lean canvas' and design thinking. A future foresight workshop was another innovation-oriented event done at the POAL. It helped employees to think out of the box and imagine the port in future and their role in that.

eMPX Project helped to create an innovation process in the organisation. It also helped to link with a startup firm in the Auckland regional ecosystem for the building of the application. Interactions with the startup has positively influenced the otherwise traditional POAL software and project teams. The use of agile methodology, user experience analysis and design thinking were some of the highlights of this interaction. More than anything the external collaboration induced employees to collaborate internally and the resistance to knowledge sharing has been reduced.

University project involved student teams interact with different departments for projects related to their 'Technology Management' course at the University of Auckland. Some of the projects were on new technologies like drone and the possibilities at the port. One other project was related to the knowledge management system at the port including the effective use of digital tools for management communication. Both the projects required students to interact with multiple teams in the port. This in turn connected the silos and generated fresh thinking at the port. Diversity in the student team as well as the port were properly applied for the benefit of both parties involved.

The angel funding for a startup named 'Freight fish' by the port in association with 'Icehouse angels' was another interaction with the Auckland regional innovation ecosystem. Startup team was composed of recent graduates with very fresh innovative ideas. The team were funded as part of the long-term strategy of POAL. Events were organised when the POAL employees were given chance to interact with the startup and learn from their innovative spirit.

Regular meetings between the innovation manager, POAL executives and the researcher was helpful in the transfer of knowledge as well as giving an outsider's impression of the inside dynamics in the port. These meetings were very valuable from the research point of view and at the same time opportunities to plan the innovation strategy at POAL. All the above interactions helped to create a culture change in a very traditional firm and highlighted the importance of ecosystem mindset and collaboration.

4.5.10 Recommendations

The recommendations are aimed at recognising the ongoing innovations and to provide a roadmap for continued innovation at POAL. Innovation needs to be viewed as a marathon rather than a sprint and requires a holistic view to address the fundamental factors. At the same time 'over-engineering' can negatively affect the creative process. Hence recommendations are put under different themes which will help to create a thought process to derive the best way forward for the firm.

Induce Culture Change

Cultural change including mind set, attitude to risk, uncertainty and even the process of project execution is the basis for innovation.

- Create foundations for a 'learning-organisation' attitude and agile mind set.
- Encourage experimentation and having tolerance for mistakes.
- Bring in voices from outside the organisation and outside the industry.
- Encourage 'creative collision' through connectivity and conversations.

Improve Knowledge Sharing

Knowledge sharing within the organisation and also with supply chain partners will help to keep the innovation relevant and sustainable (Odenthal et al., 2004).

- Continuously develop and expand internal knowledge base and make it visible and searchable.
- Encourage knowledge sharing from experts or teams within the firm and also external to the firm.
- Share innovation case studies, best practices and methods to other parts of the organisation.
- Create enablers for active use of online platforms and tools for knowledge sharing.

Increase internal and external collaboration and engagement

Partnerships and collaboration are key to promote innovation (Lee, Sang M. et al., 2012). There are clear rewards for this approach in terms of addressing the knowledge gap and time to market.

- Nurture a culture of open communication and engagement both internally and externally.
- Actively seek external sources of ideas and resources and share with other firms.

- Increase network ties with industry partners and build collaborative relationships.

Encourage open innovation

Successful innovation ecosystems create virtuous cycles of external innovation partnerships which drives internal dynamics.

- Open innovation approach in partnership with universities, start-up firms and SMEs in NZ.
- Develop an organic, flexible and externally focused cultural orientation and an ecosystem mind set.
- Create a flexible framework to engage with smaller companies and start-ups and also partner with innovation hubs, universities and research labs for open collaboration.

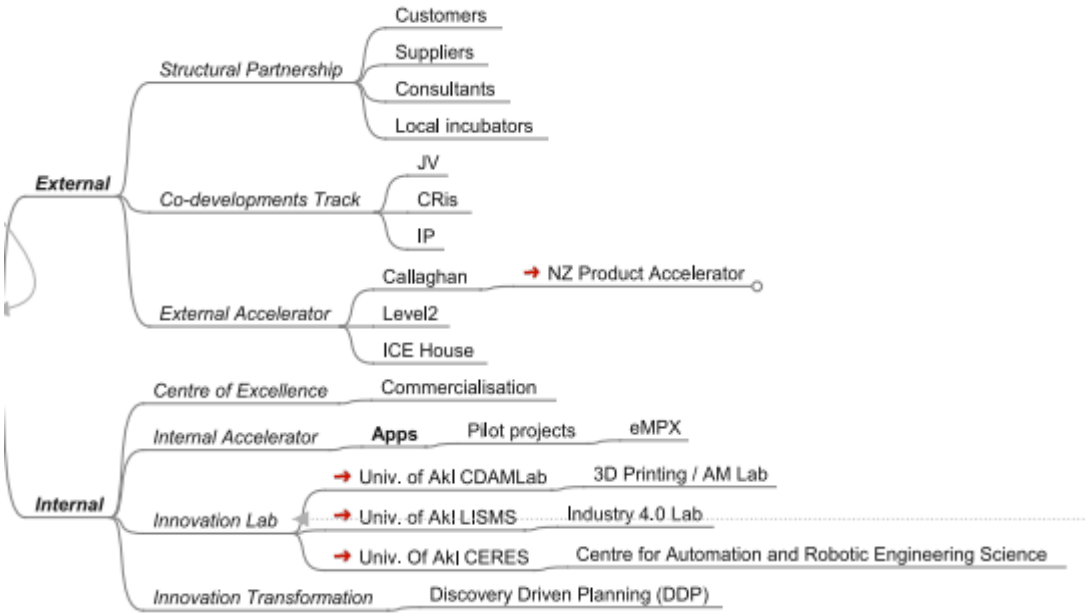

Figure 5-17 Collaboration framework with external innovation entities and POAL

The above diagram (figure 5-17) is the output of various discussions on how to improve the innovation capability of the organisation. The immediate and practical step is to improve internal and external collaboration and knowledge sharing with all actors in the innovation ecosystem.

5.5.11 Conclusion

Setting up the foundations for innovation and embed it in the organisational dynamics can take many years of focused approach. Many organisations have done it successfully after overcoming barriers and with great results. Innovation needs leadership, incentives and top management support which are key in any transformative project. The capability of the firm to tap into the

available knowledge base and effectively engage with outside partners could become a clear differentiator in this journey.

Ecosystem mind set needs to be ingrained as part of the organisation's culture. Organisational culture depends on narratives and deep-rooted patterns of expected behaviour which is shaped by the group norms. This can be extremely slow and difficult to change even when change is acknowledged to be necessary. Collaborative innovation and better engagement can help form a creative mentality and entrepreneurial drive in the organisation and create a culture change.

To embed innovation as a core competence, it is essential that the organisation has structures for orchestrating and supporting innovation. This includes frameworks for knowledge sharing, collaboration, engagement and ongoing communication and conversation about innovation. Innovation by practise is a good strategic approach. It is good to have successful innovation stories to talk about. But it is also important to have enough number of pockets of innovation to build a critical mass of innovation activities that permeates the entire firm.

5.6 Case Study Discussion

Innovation is occurring in the case study firms but there is potential for improvement. The innovation capability level of both the firms are in the 'managed' level (level 2 in the capability matrix) which shows that it is highly reactive to the circumstances. This shows a lack of innovation leadership by the firms and missing a long-term strategic view of using innovation to its advantage. It was heartening to see that they have started thinking of assessing their innovation capability and have the intention to improve it over time. The term 'innovation' is used loosely and many continuous improvement programmes are assigned as innovative projects. Innovation is typically incremental, as firms focus on small improvements and changes to their core products and services with little investment in radical innovation.

The firms under study were industry leaders in their domain of expertise and having a monopoly in New Zealand. Lack of competition has reduced their motivation to innovate and to spend resources on R&D. The comfort offered by their market position has reinforced fixed mindset, silos and corporate hierarchy in the firms under study. However, the firms were willing to analyse their innovation capability and try out innovation projects even though at a smaller scale. The case study firms very rarely interacted with the external innovation ecosystems (as shown in the figure 5-18) other than the supply chain partners and have only a very limited partnership with universities. Research institutions were totally outside the scope of interactions. There seems to be a lack of sense of the real benefit of collaboration and engagement.

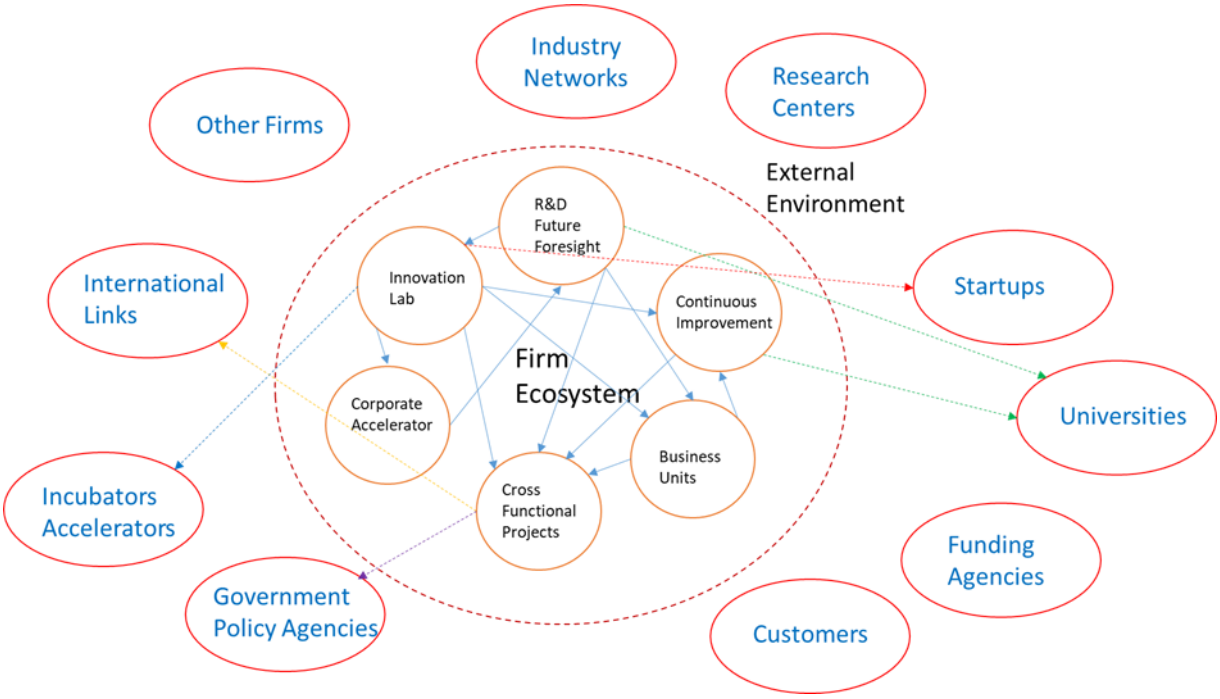

Figure 5-18 Limited external interactions of the case study firm

The study found that innovation in the firms is constrained by lack of leadership and management capability, a general lack of collaboration between firms and between firms and other organisations. While individuals and groups within firms do have strong and fruitful relationships it is not of systemic nature that allows innovation to flourish. The collaboration and linkages expected within a regional innovation system are largely absent and are thus constraining innovation. A limited amount of collaboration and knowledge sharing happens between the case study firms and the regional innovation ecosystem and there is a huge potential to improve on these fronts. Real collaborative innovation or open innovation is not happening.

Resources are another major constrain that the firms have in making innovation a success. Lack of innovation skills and the time which can be put to innovation related work are the main drawbacks. Giving training for employees in creative problem solving and having people with core innovation skills is missing in the firms under study. Often times the operational intensity of the firm squeezes out the limited resources and time which are available for innovation. There is an information hierarchy in the firms under study and this causes communication discrepancy between the higher-level executives and employees. The corporate hierarchy is being repeated in areas of knowledge transfer and communication. Bureaucracy is prevalent and is eating up the firm productivity.

The case study firms may not be utilising technology to its full potential to enhance innovation. New Zealand firms in general are slow adopters and wait until equipment or application is well established in foreign markets before the technology can be introduced into the local market. Firms

spend far less on capital compared to the labour according to different studies on New Zealand economy. There is a lot of catching up to do before the firms are on par with international firms. Lot of productive time is being lost because of the use of outdated legacy systems. This is taking away valuable time which could be used for innovation or other value-added works.

The case study firms had various gaps in their capability to have successful innovations. The success of innovation in the firm is dependent on various factors like the risk perception, upper management support, innovation processes in place, knowledge absorption, management skills for marketing and commercialisation and working collaboratively with teams inside and outside of the firm. The firms were to a large extend following conventional project management techniques which lacks the flexibility and adaptability which are needed for innovation. The idea to execution process suffers from rigid structures and control mechanisms which often kill innovation at its birth. Firms are held captive to the financial structure and organisational culture which usually allocate resources toward improving the performance of existing products. The apparent uncertainty involved in the early stages of innovation process requires a flexible and bold approach.

International linkages were seen but not utilised effectively so that there is real knowledge transfer and learning. Most international connections are informal and rely heavily on personal relationships. Both the case study firms were part of the industry networks but conducting collaborative projects were beyond the scope with those networks. There was a definite knowledge and capability gap between the New Zealand firms and the industry best players. In spite of this there is a lack of motivation to form successful collaborative innovation initiatives.

The study of the firms in relation to the Auckland regional innovation ecosystem showed that businesses were mostly inward in their focus. They did not take active role in engaging with the resources the regional innovation system had on offer. Firms in their supply chains and other firms in their industry were generally not considered as key sources or partners for innovation. While firms recognise Auckland's academic and research institutions as sources of future employees, they make very little use of the availability of research skills and knowledge for innovation. Both the firms hardly interacted with any of the research institutes or university research in a productive way. There were very few interactions with start-up firms or the entrepreneurial ecosystem.

In spite of all missed opportunities, we found certain interactions with the external ecosystem have created a positive effect on the firm level culture, attitudes in collaboration and knowledge sharing. These are shown in the table below. Interaction with outside entities have opened up avenues for internal cooperation and idea generation. This sometimes help in linking the silos and created an

atmosphere where conventional ways of thinking are challenged. Deeper levels of external interactions were absent, but we could capture a sense of what positive changes can occur with an ecosystem mindset within the organisation.

Firm	Action	Innovation Factor
Air NZ	Elog : Boeing and Ultramain as suppliers	Collaboration
Air NZ	Elog : Visit by KLM, SAS and Visit to other airlines	Knowledge sharing and culture
Air NZ	Student projects with UoA	Internal culture, collaboration and knowledge sharing
Air NZ, POAL	International interns and employees	Culture change and knowledge sharing
POAL	Innovation Hour	Culture change
POAL	Empx : Collaboration with startup	Culture change and knowledge sharing
POAL	Investment in startup firm	Collaboration and culture change
POAL	Future foresight workshop	Culture change and knowledge sharing
POAL	Student projects with UoA	Internal culture, collaboration and knowledge sharing

Figure 5-19 Positive interactions of the case study firm

The major gaps in the innovation capabilities of the firms under study was on innovation culture, knowledge sharing and collaborative mindsets. These were very evident in the silos which were prevalent in both the firms. Silos created subcultures and acted as inhibitors to knowledge sharing and collaboration. Another major observation is on the potential for interaction between the firms and the local and national actors in the innovation ecosystems. The three factors of influence which were quite apparent in the case study research are culture, collaboration and knowledge sharing. More study needs to be done to ascertain the exact effect of these factors on the firm level innovation ecosystem.

5.6.1 Organisational Culture

Organisations are composed of different groups of people belonging to different subcultures. The understanding of an organisation as a whole varies among the groups depending on how people orient themselves as belonging to a particular group. It also depends on how the group sees itself, differentiates itself from the other groups and identifies with the particular values and ideas of the organisation. This creates silos and rigid boundaries of engagement between different departments in the same organisation. The complex interaction between individuals and groups within the firm determines engagement with other firms and the external entities and vice versa.

Another effect of the organisational culture was seen in the change management dynamics. Innovation is in effect a problem solving and change management process and requires agility and vigour in execution. Traditional mindsets will hamper this and will try to maintain the status quo. Sharing of knowledge and collaboration between groups require an open culture and proper communication channels. Here also silos and the lack of collaboration mindset will pose challenges to organisational engagement dynamics.

5.6.2 Collaboration and Knowledge Sharing

Innovation is essentially a process which is stimulated and influenced by many different actors that are internal and external to a firm. Taking a systems approach to understanding the relationships between these factors and actors is essential to understanding innovation performance. Firms do not innovate in isolation but instead interact with other local, national and international institutions. Institutions and the local ecosystem have a major role in shaping up the knowledge flows and collaborative framework for innovation to become a success. Firms have link with their supply chains, education and research organisations, funding agencies and regional innovation ecosystem partners as part of the innovation process.

We found that collaboration and knowledge sharing go together and affects each other positively or negatively. Both of these are essential elements for developing an innovation ecosystem. These are affected by the organisational culture and mindset. But we also found that interaction with external entities can induce a change in firms' attitude to collaborate and share knowledge. External interaction and having a diverse workforce have an effect on the organisational culture which in turn affects collaboration and knowledge sharing. Once the firm starts to collaborate or share knowledge the internal culture will also change. So, these three factors can either create a synergy or the lack of any of these factors can negatively affect the firm, its internal ecosystem as well as external interactions.

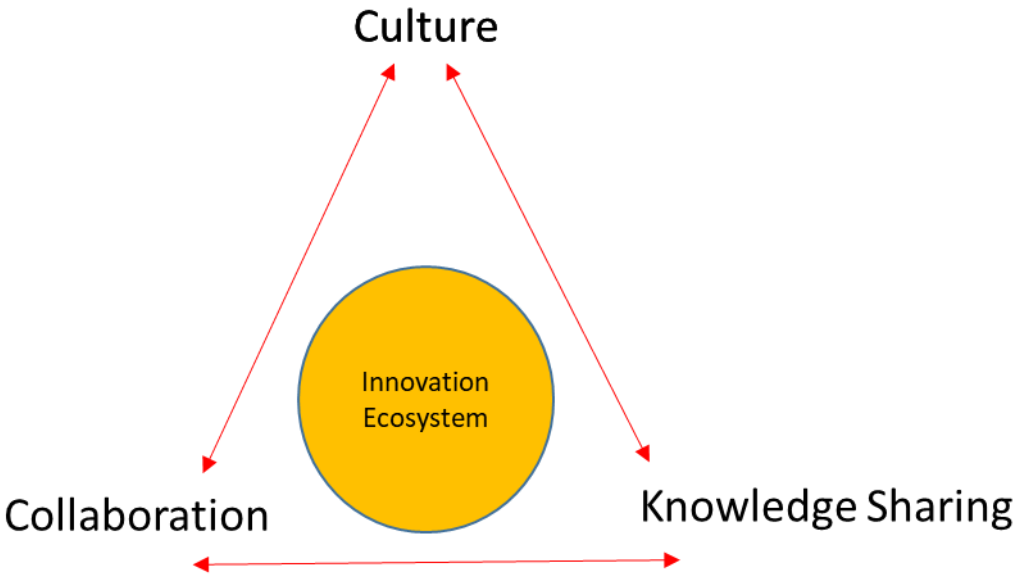

Figure 5-20 Virtuous cycle of firm level innovation ecosystem

The conclusion we can reach is that culture, collaboration and knowledge sharing are the key ingredients to develop a dynamic and successful innovation ecosystem internally as well as externally for a firm as shown in figure 5-20 above. More study on these three factors will give an idea of the underlying elements which can influence setting up a dynamic innovation ecosystem.

5.6.3 Innovation ecosystem and country effect

The context in which the firm operates including the region, industry, leadership and organisational structure matters while evaluating the effects of culture. The values of the national and regional cultures in which a firm is embedded can influence patterns of behaviour within the firm. Even though Auckland is the largest city and the commercial hub of New Zealand, it has certain weaknesses regarding the innovation ecosystem as shown in chapter 2. Innovation indicators and benchmarking with other regions suggest that the greatest weakness in the system is the lack of connection between firms, and between firms and other ecosystem partners. This combined with the New Zealand specific cultural effects, mindset, aspirations and geographical limitations shows systemic changes are required to create a vibrant innovation ecosystem.

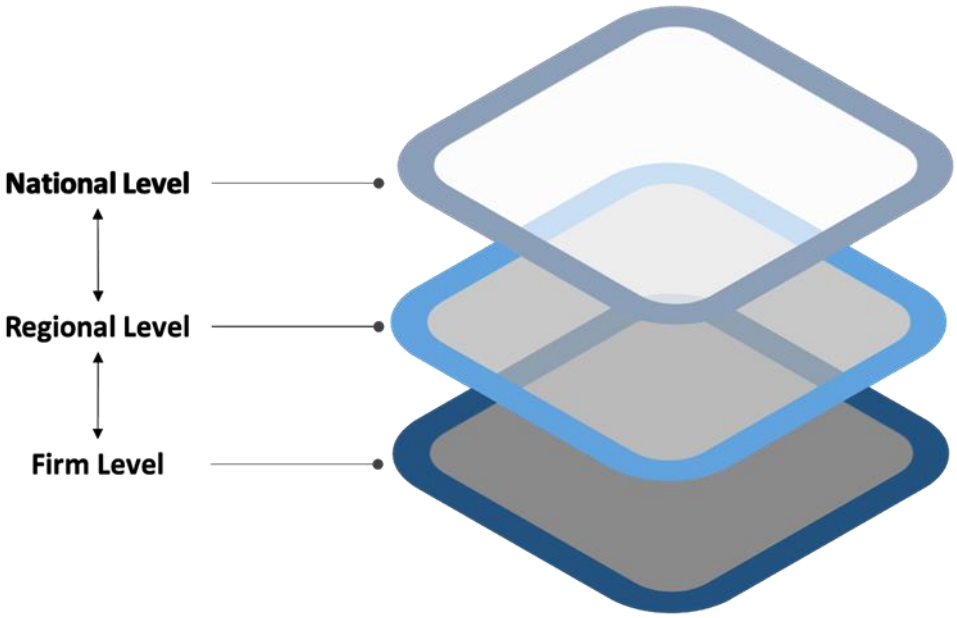

Figure 5-21 The three layers of influence for innovation ecosystems

Feedback from the case study firms as well as close observations give the impression that the organisational dynamics and the way firms interact with the external ecosystem elements are to a great degree influenced by the national and regional effects. This is shown by the three layers in the figure 5-21. Studies have shown that in a vibrant national innovation ecosystem, the regions as well as the firms have a different innovation dynamics compared to countries which are less innovative. This relationship is studied in detail to understand the effects of New Zealand innovation ecosystem on its regions, in this case, Auckland and on the firm level. Hence, an analysis of different country reports on New Zealand is undertaken in chapter 3. The results of the case study as well as country policy analysis has helped in reaching a more holistic view of the innovation ecosystems and the firm performance in those ecosystems.

5.7 Summary

This chapter looked at the case studies at the two New Zealand organisations. Survey, interview and observational data is collected and analysed to find out the innovation capability of these organisations. The data gives a similar picture from both organisations. Prevalence of silos, inability to share knowledge, barriers to collaboration and a culture which is not suitable for innovation are the main findings. The very few interactions with external entities have positively influenced the internal dynamics and culture within the firm. A positive cycle of interactions is possible between culture, collaboration and knowledge sharing internally in a firm and also in external interactions.

The overall New Zealand innovation culture and economic factors have an influence on the regional innovation ecosystem as well as on the firm level internal ecosystem. Chapter 3 has looked deeper

into the national innovation ecosystem characteristics and its effect. The next chapter will look in more detail on the three primary factors of culture, collaboration and knowledge sharing to understand the core elements which can influence creation and sustenance of a dynamic innovation ecosystem.

6.0 Culture, Collaboration and Knowledge Sharing

In this section we look at literature on culture, collaboration and knowledge sharing and also at the theoretical models associated with them. From the case study research and observations, we concluded that these three factors are crucial in creating an innovation ecosystem inside as well as outside the firm. External interactions have found to have benefits to change the corporate culture and at times have also helped the dynamic nature of the firm. The regional and national level ecosystems and the way people perceive those have an effect on the firm level innovation. Here also the interplay between the factors of culture, collaboration and knowledge sharing are found to be important. The following literature review will look at these relations and interactions.

6.1 Culture

Organisational culture is defined as the deep-seated values and beliefs shared by people in a firm. It refers to a set of basic assumptions that worked so well in the past that they are accepted as standards within the firm. Culture has an influence on the degree to which creativity and innovation are stimulated in an organisation (Martins et al., 2003). Creativity and innovation will flourish only under the right circumstances. Values, norms and beliefs can either support or inhibit creativity and innovation and can influence individual and group behaviour. Successful organisations have the ability to absorb innovation into the organisational culture and management processes (O'Reilly & Tushman, 2008).

People are attracted to organisations with similar values to their own. Organisations are more likely to select individuals who seem to fit in with their culture. Thus, culture becomes a self-reinforcing social pattern that grows increasingly resistant to change and outside influences (The culture factor.2018). Individuals that have internalised the organisational values apply them as a form of self-discipline (Büschgens, Bausch, & Balkin, 2013). Those values will also be applied in project groups and in development teams. While development teams may be formed and disbanded with certain projects the organisation forms the steady frame of those activities.

Firms that are known for their ability to create and commercialise new technologies attribute this to their unique cultures (Büschgens et al., 2013). Organisational learning is a prerequisite of a flexible organisation because it allows adapting to a changing environment. The adoption of innovation is intended to contribute to the firm's effectiveness and competitiveness so that it can adapt to changing external conditions (Damanpour & Wischnevsky, 2006). Change occurs when organisations evolve from old behaviours and methods to new ones.

Culture impacts the way each of the different ecosystem's actors performs, develops an innovation and also determines the rules of engagement (Rabelo & Bernus, 2015). Organisational culture is a clear determinant of innovation strategy (Naranjo et al., 2011). Externally oriented cultures will be associated with innovation orientation while internally oriented cultures will be associated to the imitation orientation. Adhocracy cultures will have a positive effect on innovative orientation while hierarchical cultures will foster an imitative orientation.

Organisational culture consists of a set of social norms that implicitly define types of behaviours within the boundaries of the firm (Cabrera et al., 2001). While some of the norms will permeate the entire firm, different groups within the firm might develop their own subcultures which creates silos. The most difficult task is to be able to implement and set up processes to create a corporate culture that promotes innovation. The two core elements of open innovation are an open culture to new ideas and effective processes to capture and act upon these ideas (Jaruzelski, Loehr, & Holman, 2011).

The degree of support and encouragement a firm provides its employees to take initiative and explore innovative approaches will influence the degree of innovation in the firm (Sarros, Cooper, & Santora, 2008). Studies have shown that a competitive, performance oriented organisational culture is positively associated with a good climate for organisational innovation. Innovative organisations could accumulate knowledge and diffuse it inside the firm, motivate employees, overcome obstacles and have continuous innovation.

Khazanchi, Lewis and Boyer explore how organisational values impact process innovation (Khazanchi et al., 2007). Flexibility enables creativity, empowerment and exploration which are key for innovation. Control, on the other hand encourages efficiency, productivity and stability. Flexibility values foster a culture of experimentation and empowerment while control values may set boundaries that facilitate management and evaluation. Efficiency culture are suited for process innovation and firms of innovative culture are good at product innovation (Lee et al., 2008). Individualism is positively related to the invention phase whereas collectivism is beneficial for the commercialisation of innovative ideas when collaboration within the firm and with other stakeholders is more important (Černe, Jaklič, & Škerlavaj, 2013). In collectivistic cultures, management innovation plays a more important role in enhancing technological innovation than it does in individualistic cultures.

Ambidexterity or the ability of a firm to simultaneously explore and exploit enables a firm to adapt over time (O'Reilly & Tushman, 2008). The processes and skills required for exploitation are

fundamentally different than those required for exploration. Exploration is about discovery, autonomy and innovation while exploitation is about efficiency, increasing productivity, control and variance reduction. Returns to exploration are more uncertain and hence it demands a certain risk management.

Each organisation has its unique culture which develops overtime to reflect visible and invisible identities of the firm (McDermott & O'dell, 2001). Radical innovations are associated with organisations that have an experimental culture, a decentralised structure, flexible work processes, diversity and strong technical competencies (Bierly, Damanpour, & Santoro, 2009). Incremental innovations are associated with firms that have an efficiency culture, a centralised structure and formalised roles and coordinating mechanisms.

The amount of risk taking is an output of the cultural factors in the firm which has a direct impact on innovation. This can be achieved by creating a tolerant atmosphere in which mistakes are accepted as part of learning experiences and assuming that there is a fair chance of risks being successful (Martins et al., 2003). Unless the culture honours ideas and supports risk taking, innovation will be stifled before it begins (Wycoff, 2003). An environment that is flexible, empowering, welcomes ideas, tolerates risk, fosters respect and encourages creativity is crucial to innovation. A tolerance for risk signifies the willingness to deal with uncertainties and is related to the value of flexibility and growth (Büschgens et al., 2013). Fostering the flexibility and autonomy of people with the requirement to create new ideas have a positive effect on innovation.

Openness in communication and trust factor are crucial elements which could positively change the organisational culture (Martins et al., 2003). Values like flexibility, freedom and cooperative teamwork will promote creativity and innovation (Arad, Hanson, & Schneider, 1997). Rigidity, control and order will act as barriers to creativity and innovation. Diversity and prevalence of complementary talents will promote creativity and innovation. There are various studies which show the important role of institutional trust in driving organisational innovativeness (Ellonen, Blomqvist, & Puumalainen, 2008). High levels of trust have a positive effect on the effectiveness and quality of organisational knowledge sharing and innovation. Trust influences both employee support for change and the probability of successful change which in turn influence the degree to which creativity and innovation are promoted (Martins, Ellen & Martins, 2002).

Morcillo, Rodriguez and Rubio looked at regional and national level impacts of culture on the firm level (Morcillo et al., 2007). If a company seeks to obtain a suitable culture of innovation it must be supported by a government policy which facilitates and strengthens the efforts made by the

company. Individual creativity for initiating innovation is not only influenced by organisational factors but also by the regional culture (Kaasa & Vadi, 2010). The openness towards new experiences varies in different cultures. There is a strong argument that the capability of a country or region to initiate innovation is related to its culture.

Individuals bring their personal values, attitude and beliefs to the workplace and these are reflected in different national cultures (Lok & Crawford, 2004). How personal values fit in with the existing organisational culture and the influence of national culture on personal values could determine the difference in firm's culture. Cultural differences influence the relative performance of firms in different countries based on the innovativeness of a society (Shane, 1992). Innovation is more likely to occur if a society is less hierarchical since bureaucracy reduces creative activity. Individualistic societies value freedom more than collectivistic societies and freedom is necessary for creativity.

National culture traits directly influence the relationship between perceived technological uncertainty and alliance formation (Steensma et al., 2000). A high uncertainty avoidance culture diminishes the flexibility, creativity and innovation and could bring adverse influence on the development of organisational learning culture (Škerlavaj, Su, & Huang, 2013). When organisations and their employees are hesitant to embrace uncertainty and ambiguity, they are less motivated to try something new which is an essential characteristic for innovation.

Investigating how specific national cultural characteristics influence innovation processes is relevant for both managers and researchers (Černe et al., 2013). Such an approach puts research on innovation into a broader context by pointing out the differences in innovation processes at the organisational level within country specific national culture characteristics. Managers in more collectivistic societies need to be more careful during the initial innovation stage when they need to put extra effort on emphasizing freedom and independent thinking. Managers in more individualistic cultures need to put more energy into stimulating cooperation and collaboration during the final commercialisation stage of the innovation process.

National culture and organisational culture have a profound influence on the level of entrepreneurship and innovation in firms (Zhao, 2005). In highly collectivistic cultures, innovation policies should be designed to offer incentives for innovative ideas in the first stage of the innovation process (Černe et al., 2013). Innovation policies in individualistic cultures should be designed to provide support for collaboration and engagement with other firms.

Organisational culture with a development orientation has direct effect on a firm's innovation performance (Lau & Ngo, 2004). Organisations are social as well as physical constructions and

therefore an understanding of organisational culture can help to shape the process of innovation and firm performance (Hogan & Coote, 2014). Culture shaped by management through organisational values, norms and artefacts encourages and supports innovative behaviours. Embedding values and norms in organisational artefacts would assist higher levels of innovation (Schein, 2010). Artefacts can be a powerful mechanism for communicating and endorsing values that support innovation. Schein's model as shown in the figure 6-1 below, provides a framework for thinking about organisational culture and fostering cultures of innovation.

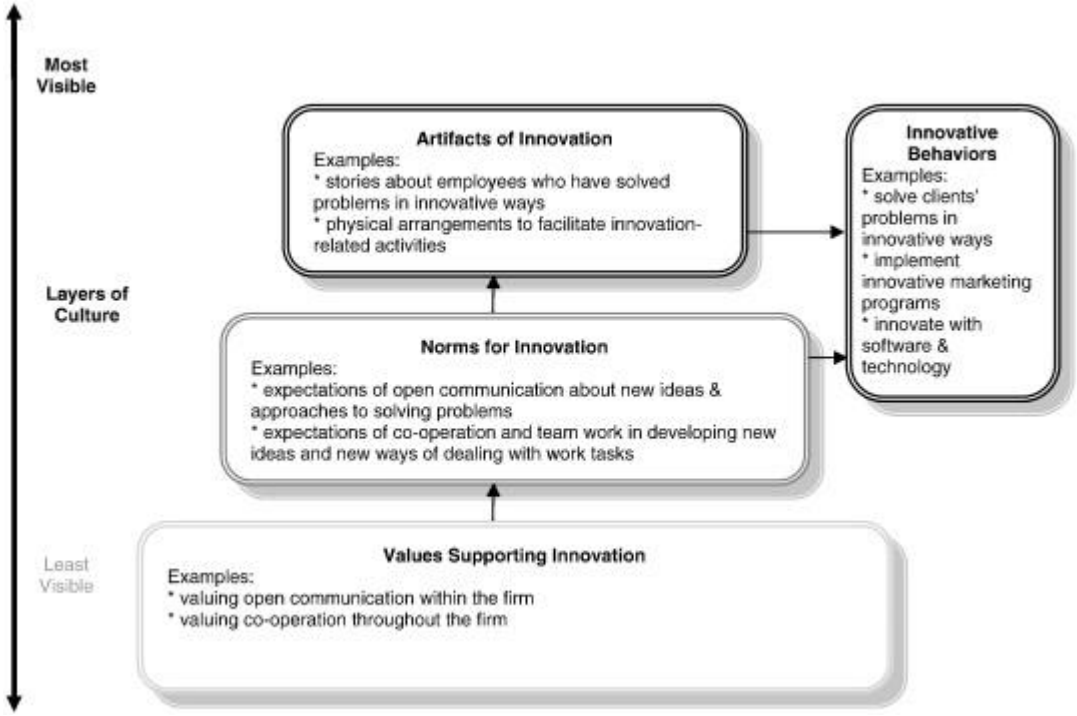

Figure 6-1 Schein's model of organisational culture (Schein, 2010)

Individual culture is based primarily on values which are learned in early childhood from the family (Cabrera et al., 2001). These values are strong enduring beliefs which are unlikely to change throughout the person's life. Occupational culture is comprised of both values and shared practices acquired through schooling and professional training. Organisational culture is based on differences in norms and shared practices which are learned in the workplace and are considered as valid within the boundaries of a particular firm.

6.1.1 Mindset

MIT academics Otto Scharmer and Katrin Kaufer (2013) has popularised a concept of iceberg to define the organisation mindset. The below-the-surface factors have to be understood and addressed before shifts in behaviour and culture can be realised to drive organisational health. "Above the surface is the visible behaviour repeated and reinforced by the organisation every day.

Under the surface are employees' thoughts and feelings, their values and beliefs and their underlying needs, including their fears and the threats to their identity"(Scharmer & Kaufer, 2013).

An innovation mindset is a mental framework that fosters development and implementation of new ideas and new ways of doing business (Lahiri, Pérez-Nordtvedt, & Renn, 2008). This mindset promotes innovative thinking, stresses technology development and greater R&D efforts within the firm. It decreases the likelihood of organisational decline caused by rapid technology change. The lack of an innovation mindset result in continued design of commodity products and services, the same level of knowledge generation within the firm and gradual loss of competencies.

Innovation as a mindset deals with internalisation of innovation by members of the organisation and advancement of a supportive culture throughout the firm(Kahn, 2018). Innovation flourishes when employees and the organisation as a whole instil innovation so that favourable characteristics emerge. Innovation mindset needs to be ingrained as part of the organisation's culture. An entrepreneurial mindset will positively affect a firm's ability to apply the external knowledge. This will encourage the constant pursuit of innovation and learning and promotes openness in communication and knowledge sharing.

Individual's entrepreneurial mindset can be defined as the ability and willingness to rapidly sense and act under uncertainty about a possible opportunity. The psychological processes of an individual within a firm influence the organisational culture and organisational culture influences the psychological processes of that member (Shepherd, Patzelt, & Haynie, 2010). There is also positive interdependence of an individual's mindset and the organisational culture in which the individual is embedded.

The foundation of the entrepreneurial mindset is cognitive adaptability which is the ability to be dynamic and flexible under uncertain environments (Haynie et al., 2010). It is important that both employers and individuals recognise and develop their intrapreneurial attributes and mindset. Intrapreneurs have two linked perceptions of the world (Thompson et al., 2014). They see it as a world full of opportunities and as a world of actions in which they can make things happen. The brain links these perceptions to give a positive view of the world.

Fixed mindset is a state in which we avoid challenging situations that might lead to failure (Dweck, 2016). If we fail, we try to focus on rationalising the failure rather than learning from it and developing our capabilities. With a growth mindset our focus will be on learning and development and we actively pursue the types of challenges that will likely lead to both learning and failure. A growth mindset shows that by working together we can create more value than if we work

individually (Hagel & Brown, 2010). These relationships and the process of creating value together fosters trust. The levels of collaboration and trust deepen with time creating a more valuable relationship.

Intrinsic motivation is one of the most important sources of creativity (Deci & Ryan, 2010). It is a type of motivation based on one's natural interest in various activities that provide novelty and challenge. For people to be intrinsically motivated for an activity they must be doing it because they find it interesting. Intrinsically motivated behaviours do not require external rewards. It involves an ongoing cycle of finding optimal challenges and interesting activities that provide stimulation and repeating this cycle.

The mindset is a way of thinking that influences the way someone views and acts upon a situation (Sidhu, Goubet, & Xia, 2016). Being able to pivot and to team up with others for the project requires a specific type of mindset and behaviours. This includes one's ability to trust others and to be trusted in return. Mindset aligns employees and manifests the culture needed for innovation to happen. It is about instilling a mindset that prepares the individual and organisation so that there is proper engagement in the innovation process to achieve the desired outcome.

Silos are organisational entities that lack the desire or motivation to coordinate with other entities in the same organisation (Serrat, 2017). Structural barriers often cause units to work against one another and fosters a culture whereby the incentive is to maximise the performance of the silo and not that of the firm. Silos come about because of lack of opportunities for people to come together and when there is a lack of collaborating spaces. When teams or groups exhibit silo mentality it refers to a position where systemic thinking and the vision of the larger organisation are absent (Cilliers & Greyvenstein, 2012). A single team or group will also feel safe within the team and view the other silos and teams in the organisation as the one to fight against.

Organisational culture depends on narratives and deep-rooted patterns of expected behaviour which is shaped by the group norms (Akerlof & Kranton, 2013). This can be extremely slow and difficult to change even when change is acknowledged to be necessary. Collaborative innovation and better engagement can help form a creative mentality and entrepreneurial drive in the organisation and create a culture change.

A collaboration mindset converts all challenges into opportunities by allowing firms to form successful partnerships that can lead to synergy by combining complementary resources (Lahiri et al., 2008). Such a mindset enables employees and managers to realise the significance of networking and to overcome communication and cultural barriers. A collaborative culture is the

element that fosters people to work together, to share and co-create value (Salampasis, Mention, & Torkkeli, 2015). Collaboration makes people focus on sharing knowledge between eco system partners. The organisation should have the ability to manage both the external and internal knowledge and make an effective use of it.

Open innovation is an organisational mindset and drives culture, collaboration, community engagement and organisational trust (Salampasis et al., 2015). It is also highly related to the creation of a knowledge sharing organisational culture. An open knowledge transfer mindset takes place within a knowledge sharing culture. Strategic leadership must ignite employees' creativity by encouraging new ideas and curiosity. This leads to the creation of a knowledge sharing culture which incorporates trust and builds upon new knowledge creation.

Thinking about innovation ecosystems requires a shift in mindset about the need to manage the interaction of entities within and outside the ecosystem (Adner & Euchner, 2014). We live in internal ecosystems as well as external ecosystems at the same time and all the issues that apply to your external ecosystem also apply to your internal ecosystem. The ecosystem benefits from the network effects of adding more participants of diverse capabilities. The role of the ecosystem is not just to connect and mobilise existing resources but to build relationships that help all participants get better faster (Hagel et al., 2010). This leads to a virtuous cycle as each participant learns faster as more participants join the ecosystem.

Ecosystem mindset is an understanding that the organisation is not a bounded entity but part of a wider ecosystem (Govindarajan & Srinivas, 2013). Effective ecosystems manage to turn outsiders into collaborators. Successful innovation ecosystems make people outside the company smarter, richer and more innovative (Bosman, Chelberg, & Fernhaber, 2017). They cultivate profitability by encouraging others to create valuable new offerings. Success comes from exploring how to make one's partners more valuable innovators.

6.2 Collaboration

Collaborative innovation is one that is performed by individuals or teams from multiple firms, academic and research institutions, unlike innovation performed within a single organisation (Ketchen Jr, Ireland, & Snow, 2007). Collaborating firms can improve the pace of innovation by having complimentary resources and capabilities (Gnyawali & Park, 2011). It was observed that inter-organisational collaboration with different partners contributes to the innovative performance of firms (Faems, Van Looy, & Debackere, 2005). It can provide a synergy between firms by combining complimentary capabilities and enable faster development of innovations.

Firms enter into collaborative arrangements because they do not have internally all of the necessary resources and because they could reduce the risks associated with innovation (Tether, 2002). Firms' capacity to innovate could greatly improve if they co-operated with other firms over innovation in addition to investing in R&D (Propris, 2002). Innovation policy should attempt to initiate and support inter-firm collaboration. Linkages are formed only when actors with inducements to form linkages are successful in finding collaboration opportunities. The greater the firm's competitive resource deficiency the greater its inducements to form linkages (Ahuja, 2000).

The closed innovation based on self-reliance of R&D is too slow and also costly to stay ahead of the competition. Collaborating with other players is the solution to keeping up with the skills, resources and speed and be innovative in the world market (Inkpen, 1998). Collaborative innovation empower teams with knowledge, skills and resources to carry out innovation (Lemon & Sahota, 2004). Developing dedicated team to focus on innovation has a risk that it will concentrate the innovation activities to one specific team and prevent cross learning and spread of innovation activities in the organisation. Hence developing collaborative teams within a firm is a better approach for sustainable innovation.

Innovation has gone through evolutionary steps to collaborative innovation and open innovation during the past three decades (Lee et al., 2012). Collaborative organisations are simultaneously innovative and efficient as well as agile and scalable according to Prusak (2011). It is important to understand knowledge production through both internal and external collaboration. To facilitate external collaboration, it is important that the organisation has internal collaboration culture in place. Product design, service innovation, process innovation and new venture ideas may require a complex mixture of internal and external collaborations.

Innovations emerge in social interaction in which diverse actors share complementary knowledge (Blomqvist & Levy, 2006). Collaboration capability is a required quality for actors to leverage knowledge. Blomqvist and Levy propose that collaboration capability could be seen as a meta-capability enabling leverage of both internal and external knowledge bases. It is a useful concept for analysing relational interaction on individual, team, intra- organisational and inter-organisational levels. Collaboration capability is also defined as the capability to build and manage network relationships with mutual trust, communication and commitment.

Innovation is a collective action in which firms act together with suppliers, customers, competitors, consultants and universities in collaborative arrangements (Tether, 2002). A firm's resources may extend beyond its traditional boundaries and create strategic network ties. The possession of either

technical or commercial capital can help a firm to better position itself in linkage formation opportunities (Ahuja, 2000). Firms that lack either the ability to invent new technologies or the commercialisation capital have strong incentives to collaborate as it can access the commercial or technical capital that they lack.

Collaboration indicates various forms of interactive communication between networked actors. Collaboration is important for both R&D and non-R&D innovation, but each type uses different networks (Smorodinskaya et al., 2017). In order to co-create innovations, networked actors must rely on a common strategy and joint obligations.

Shared problem solving and caring behaviour support learning and team psychological safety is positively related to learning (Bstieler & Hemmert, 2010). Shared problem solving is particularly important for both learning and time efficiency. To achieve optimal outcomes of collaborative development projects, shared responsibility between the representatives of the partner firms as well as mutual care and respect among team members are important.

Innovation frequently involves teams that are physically located across the world. Given the difficulties associated with coordinating individuals who are not within close proximity, an efficient and integrated collaborative structure is critical to the completion of interdependent tasks and achievement of goals (Batarseh, Usher, & Daspit, 2017).

Studies have shown that diverse teams outperformed homogeneous teams by bringing a broader spectrum of knowledge and experience to the group (Pinjani & Palvia, 2013). In some situations, homogeneous teams performed better by avoiding conflicts and communication problems. Mismanaged team diversity can be detrimental by causing group conflict, miscommunication and lack of trust. Different partners may strive to take control to protect their own agenda and to influence the collaboration's agenda. It is important to have clarity about why the collaboration exists, why different individuals and firms are part of it, their roles and what they expect each other to do (Vangen & Huxham, 2003).

Emotional intelligence promotes team trust, and it fosters a collaborative culture which enhances the creativity of the team (Barczak, Lassk, & Mulki, 2010). In a collaborative culture, team members are encouraged to embrace change and discuss problems openly leading to constructive engagement and consensus. Team members are guided by a common objective and work together effectively through knowledge sharing.

Research shows that team members' emotions shape their attitudes and behaviours which in turn impact unit and organisational performance (Barczak et al., 2010). Teams with higher levels of emotional intelligence are better able to inspire support and confidence in fellow team members. Members need to be able to trust that other team members will do their work effectively and efficiently. Without trust, political behaviour can emerge in the team, pitting individuals with different perspectives against each other which can undermine the efforts of the team.

According to organisation studies trust, transparency, communication and commitment are fundamental factors which can determine the success of a collaborative innovation project (Pinjani & Palvia, 2013). Different levels of trust may result in different levels of exchange and combination of resources between firms in the same network (Xavier et al., 2006). According to Ebers, if there is trust developed between partner entities the formation of network relationships is more likely and hence better coordinated (Ebers, 1997). The interacting parties can achieve control of their relations and a more reliable information exchange. This encourages development of long-term relations with their trusted partners where there is knowledge transfer.

Belkadi and Bernard (2015) introduced the concept of trust level between partners to define the collaboration strategy. It is defined as something which is built progressively overtime based on the presence of mutual interest between two organisations. Vangen and Huxham (2003) argues that management of trust implies both the ability to cope in situations where trust is lacking and the ability to build trust in situations wherever possible. This is shown in figure 6-2.

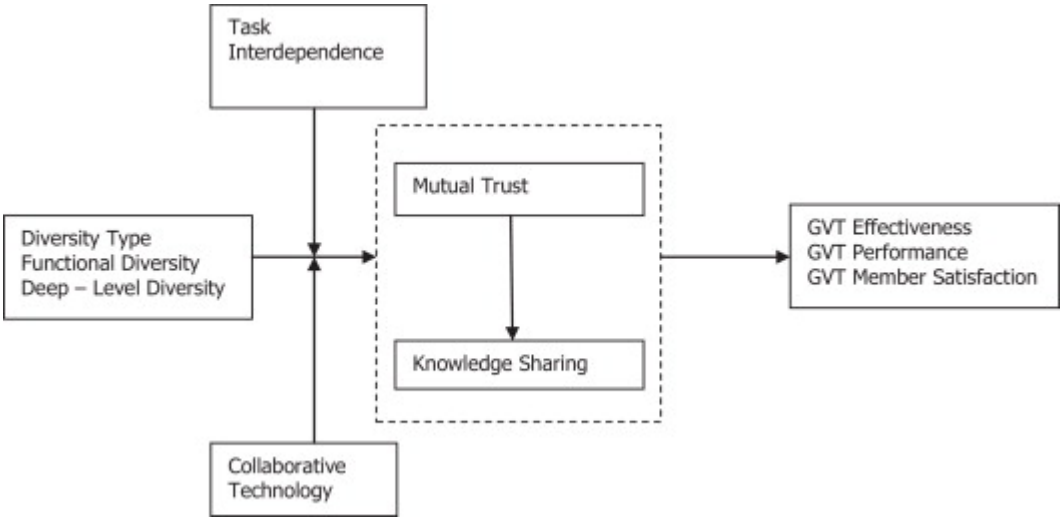

Figure 6-2 Importance of trust in collaborations (Vangen & Huxham, 2003).

(Steinbruch et al., 2021) suggests that trust contributes to the development of innovation ecosystems' dimensions. However, the literature on this topic remains absent of research exploring how the interactions among actors occur especially in relation to the existence of trust, which is considered one of the most critical factors of success in collaborative relations.

Building trust in innovation ecosystems can yield positive results not only for the actors involved but also for the ecosystem's success (Hakala et al., 2020). Because of these synergistic relations of people, knowledge and resources, ecosystems present different ways of internal collaboration, resulting in several interdependencies. For an ecosystem to succeed, the involved actors should be based in trustworthy relationships. In intense and aggressive environments that companies face today, being able to trust a partner to jointly create innovation can be a real competitive advantage.

Trust plays an important role in business relationships, since its presence can effectively allow knowledge transfer among different parties and even enhance the network performance (Massaro et al., 2019). Thus, environments where organisations collaborate with each other and establish interdependent networks, require interorganisational trust ((Donati et al., 2020);(Sharafizad & Brown, 2020)).

6.2.1 Engagement

Engagement is the degree to which an individual is attentive and absorbed in the performance of their roles. Employees will choose to engage themselves in response to the resources they receive from their organisation according to Saks (2006). There is a positive relationship between psychological meaningfulness, engagement and organisational commitment (Geldenhuys, Laba, & Venter, 2014). Employee engagement positively impacts the employee innovativeness. Employee engagement practices create the groundwork for innovation and creativity in the firm.

Collaboration in teams will often lead to higher engagement among employees (Rao, 2016). When employees are empowered, they reward the organisation by showing engaged behaviour. This engaged behaviour of employees motivates them to perform more than their duties and results in creativity and innovation in the firm. Engaged employees feel they have a real stake in the firm and hence strive to create new products, services and processes.

Trust in management influence one's engagement in the organisation. If trust towards senior management is high, it improves employee engagement (Chughtai & Buckley, 2008). Lower levels of trust have been found to lead to fear and suspicion with employees contributing less to the organisation. There can be an increase in engagement amongst employees if there is trust in the

competence and capability of the immediate supervisor. It is proposed that a high level of trust in one's co-workers can also positively contribute to employees' engagement level.

Organisational culture plays an important role in enhancing employee engagement and employees' motivation to innovate. Internal interactions within each firm will shape the external partnership and vice versa (Slowinski & Sagal, 2010). Within each entity involved in the alliance, there must be alignment on the objectives and terms of the partnership to derive the maximum benefit out of collaborations. Without alignment, different stakeholders work from different understandings of the alliance.

6.2.2 University Industry Collaboration

A university can serve as an ecosystem orchestrator by applying its intellectual, reputational and financial capital to establish and maintain a strong ecosystem (Heaton et al., 2019). The cultivation of strong dynamic capabilities by the university and its leaders will help to sustain and enhance regional innovation ecosystems. Universities can enable the free flow of information throughout the innovation ecosystem where ideas and insights can be shared, discussed and debated.

Working with universities requires not only that firms learn to work across organisational boundaries, but also that they can build the capabilities to collaborate with partners operating within a different incentive system. Frequent and recurrent research partners are likely to transfer the knowledge gained through their involvement in multiple and diverse partnerships (Bruneel et al., 2010). Engagement in a wider range of interaction channels with universities may help to overcome misalignments due to distinct institutional norms.

Most academics engage with industry to further their research rather than to commercialise their knowledge (D'este & Perkmann, 2011). Learning motivation refer to the expected benefits from gaining new insights, receiving feedback on research and accessing new knowledge through engagement with industry. Academics motivated by learning frequently engage in joint research, contract research and consulting, while motivations related to commercialisation of research lead to engagement in activities such as patenting and spin-offs.

Universities can serve as a source of refocusing on promising opportunities to prevent a declining ecosystem from becoming obsolete (Heaton et al., 2019). They can reorganise research addressing new developments in technology and reconsider the ways in which they exchange knowledge. University research with international visibility attracts national and international funds and talent to the regional ecosystem. Foresight of emerging research fields and technology developments is needed, and this is where university and industry can have collaborative research.

Franco and Haase (2015) makes an argument for the relevance of intermediators in the interaction between university and the industry. Those researchers with the greatest scientific productivity tend to engage in collaborative research projects through the bi-directional channel, whereas others are more into contracted research and consultancy through traditional channels. Muscio and Vallanti (2014) shows that academic researchers perceive four main factors that act as barriers for university-industry collaboration. Those are misalignment of incentives between researchers and firms, lack of intermediaries, misalignment between academic goals and industry needs and gap between academic research and business needs.

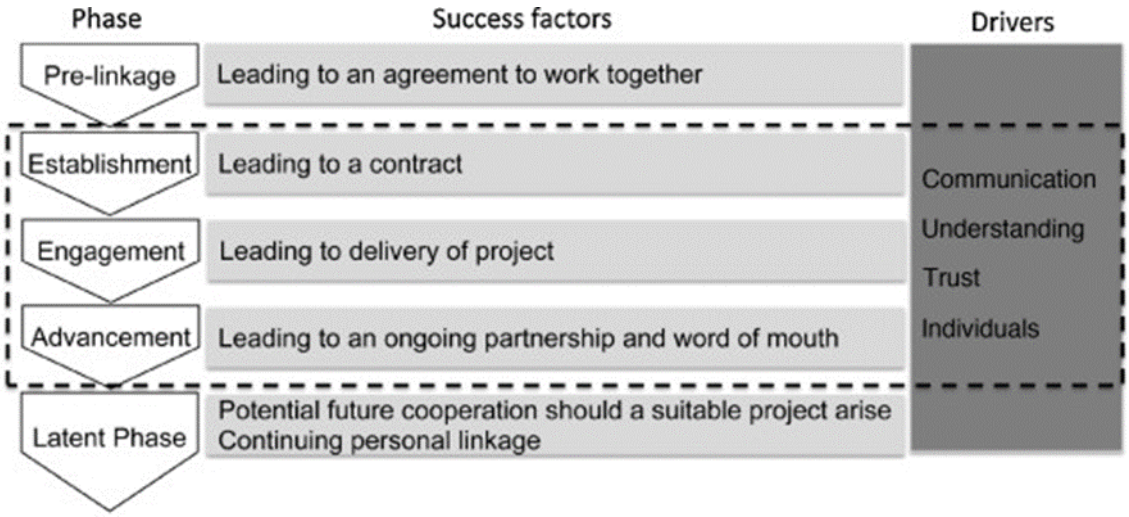

Figure 6-3 Evolution of University-Industry Linkages (Plewa et al., 2013).

Communication, understanding, trust and people, and the variations in the nature of these factors are important for successful collaborations (Plewa et al., 2013). Trust is important in facilitating university–industry collaboration since firms and universities are often required to share commercially sensitive information and tacit knowledge. The perceived barriers to collaboration are lower for academics with industrial and collaborative experience and for those who trust their industry partners (Tartari, Salter, & D'Este, 2012). The main factors that reduce barriers towards collaborating with industry are professional experience, collaborative experience working with commercial organisations and the level of trust between the academic and their industrial partners. Personal and trust-based relationships between university scientists and industrial partners are crucial for the effectiveness of knowledge transfer activities.

Laursen and Salter (2004) shows that firms which are open to external sources of knowledge also tend to use university research more intensively. R&D intensity, firm size and the regional industrial environment are important factors in the tendency of firms to use universities in their innovative activities. Academic research output is affected not only by the existence of links with the industry

but also by the degree of industry collaboration (Banal-Estañol, Jofre-Bonet, & Lawson, 2015). More engaged researchers have both higher degrees of collaboration and more research output than researchers lacking collaboration taste and networking skills. Studies shows that prior experience of collaborative research and greater levels of trust reduce collaboration barriers.

6.2.3 Open Innovation

Open Innovation is the purposive use of inflows and outflows of knowledge to accelerate internal innovation and finding markets for external use of innovation (Chesbrough et al., 2003). Open Innovation means that valuable ideas can come from inside or outside the firm and can be commercialised from inside or outside the firm as well. It is defined as a distributed innovation process based on purposively managed knowledge flows across organisational boundaries in line with the firm's business model (West et al., 2014). In addition to internal R&D, companies use external research projects, corporate venture capital, spin-offs, licensing and IP in the innovation process.

Traditional business strategy has prompted firms to develop defensible positions giving importance to constructing barriers to competition rather than promoting openness (Chesbrough & Appleyard, 2007). Open innovation is a novel business model based on harnessing collective creativity through collaboration. It embraces the benefits of openness as a means of expanding value creation for organisations. The idea of open innovation assumes that corporate innovation activities are more like an open system than the traditional vertically integrated model (West et al., 2014). Building on the resources based view and the dynamic capabilities perspective Schweitzer, Gassmann and Gaubinger (2011) propose that open innovation strategies assist companies in navigating through competitive landscapes.

Open strategy also introduces new business models based on invention undertaken within a community of innovators (Chesbrough & Appleyard, 2007). It balances value creation forces that can be found in creative individuals, innovation communities and collaborative initiatives with the value capture for successful innovations. Inbound open innovation refers to internal use of external knowledge, while outbound open innovation refers to external exploitation of internal knowledge. In the case of inbound open innovation, firm monitor the external environment to source technology and knowledge in addition to in-house R&D (Chesbrough & Bogers, 2014). In the case of outbound open innovation firms look for external organisations that are better suited to commercialise a given technology.

An organisation cannot innovate in isolation and it has to engage with other partners to acquire ideas and resources from the external environment to stay competitive (Dahlander & Gann, 2010). Internal capabilities and external resources are complementary rather than substitutions. Zahra and Nielsen (2002) argue that companies that commit to inter-firm collaborations are more flexible and have higher dynamic capabilities than companies that do not co-operate. Wayne (2012) argues that in order to successfully pursue innovation as a strategy organisation need to develop external linkages and leverage opportunities to access innovative ideas externally through open innovation.

Organisational barriers need to be overcome to ensure a smooth transition of a firm's approach from closed to open innovation (Boscherini et al., 2010). Open Innovation is highly pervasive, and it requires a firm to have a relook on organisational structures and management systems as well as on the culture, values and resources. Implementation of open innovation involves networks, organisational structures, innovation processes and knowledge management systems which are the organisational elements a firm can focus while moving towards open innovation (Chiaroni, Chiesa, & Frattini, 2011) .

Too much openness can negatively impact firms because it could lead to loss of control and core competence. Closed innovation approach does not serve the increasing demands of shorter innovation cycles and reduced time to market. An appropriate balance of the open innovation approach while at the same time building core competencies and protecting intellectual property is required (Enkel, Gassmann, & Chesbrough, 2009).

Open innovation enabled both academics and practitioners to rethink the design of innovation strategies in a networked world (Huizingh, 2011). Innovation managers who want to open up their innovation process will invest effort into finding out which external sources to integrate. They do this by collaborating with universities, buying and selling IP or start-ups that are challenging the boundary of the industry. Wherever universities have developed a dense collaboration with businesses and other external stakeholders, they have become important primary partners in open innovation networks.

6.3 Knowledge Sharing

Knowledge sharing is an important factor for innovation capability and innovation performance of the firms (Koskab, 2013) ; ((Bontis et al., 2009). Knowledge management involves activities relating to the capture, use and sharing of knowledge by the organisation. It involves the management of internal and external knowledge flows including methods and procedures for establishing closer relationships with other firms and institutions. Knowledge sharing and collaboration facilitate the

cross fertilisation of ideas and enhanced creativity. Organisations can create synergies by enabling network participants to build on complimentary skills and capabilities which will ultimately result in more effective innovation (Cormican & Dooley, 2007).

The dynamism of knowledge conversion starts at the individual level and expands as it moves through different levels of interaction (Tseng, 2010). The key problems to managing knowledge across a collaborative network are people centric (Cormican & Dooley, 2007). Firms must foster the underlying culture necessary to support knowledge sharing and collaborative needs. If an organisation does not have an appropriate culture, knowledge sharing processes will be very limited. Employees who are actively encouraged to share ideas, take risks and initiate change are more inclined to be successful at inter firm collaboration.

The willingness of individuals to share and integrate their knowledge is one of the central barriers in knowledge sharing within organisations (Sohail & Daud, 2009). It highlights the importance of interaction between the different actors in the context of knowledge sharing. For a knowledge management initiative to succeed, a knowledge sharing culture needs to be created and nurtured within the organisation (Lee et al., 2002). It has to take into consideration the social and psychological issues that might affect knowledge sharing within the organisation.

Attar presents a conceptual model on the relationship between organisational culture, knowledge sharing practices and organisation performance (Attar, 2020). The model proposes the potential measures of an organisation's knowledge sharing environment and the role of organisational culture in shaping knowledge sharing practices. Organisational culture is positively related to the firm's knowledge sharing environment and is proportional to its intellectual capital. Knowledge management cannot be effective without addressing organisational culture (Al Saifi, 2015). Organisational culture facilitates more mature knowledge management practices and also develops organisational performance.

There are different ways in which culture influences the behaviours for knowledge creation, sharing and use. Culture creates assumptions about what knowledge is and which knowledge is worth managing (De Long & Fahey, 2000). It defines the relationships between individual and organisational knowledge and creates the context for social interaction that determines how knowledge will be used. Then it shapes the processes by which new knowledge is created and distributed in organisations.

Cultural factors related to the orientation to knowledge and people are important for setting up an effective knowledge management system (Zheng, 2009). A wide range of cultural factors has been

identified as conducive to knowledge management, such as prioritisation of knowledge, critical attitude toward existing knowledge, openness and support. In a culture that has a high level of trust, people are more likely to collaborate with each other and share knowledge. Trust reassures people that they are still valued after they share their knowledge.

Investing in technology alone is not enough to facilitate knowledge sharing. To promote knowledge sharing activities, facilitation of social interaction culture is more important than extrinsically motivating employees through rewards and monetary compensation (Svetlik, Stavrou-Costea, & Lin, 2007). If employees feel less empowered then they would be discouraged to share constructive suggestions and knowledge that help make better decisions and hence knowledge sharing suffers. Firms should establish a harmonious atmosphere that fosters social interactions among employees and encourage employees to work closely together.

For knowledge management projects to be successful there needs a culture where people are willing and free to explore (Prusak & Davenport, 1998). This culture provides a conducive environment where people do not fear that sharing knowledge will cost them their jobs. Knowledge management processes are heavily influenced by the social settings in which they are embedded and are based upon organisational norms and social interactions among individuals (Alavi, Kayworth, & Leidner, 2005). The most important social context factor is the organisational culture. Knowledge sharing is enhanced by a culture where the role of knowledge, knowledge management, innovation and creative thinking is encouraged (Du Plessis, 2007). This benefits innovation as it provides knowledge as resource and at the same time provides a culture within which innovation, creativity and learning are encouraged and valued.

The knowledge management mindset is a precursor to a knowledge sharing culture (Smith, McKeen, & Singh, 2010). It is a state in which people think about how knowledge can be used in everyday work and in business strategy. Knowledge management takes place on three levels, namely the individual level, team level and organisational level according to Du Plessis (2007). Knowledge management is not solely focused on innovation but it creates an environment conducive for innovation to take place. It can play a major role in facilitating collaboration which can assist in the sharing of tacit knowledge.

Establishing trust is potentially the greatest barrier to overcome in collaboration and it must be established to allow knowledge sharing (Cormican & Dooley, 2007). It is possible to create an organisation that has an appropriate culture to enable knowledge creation, transfer and reuse. This

is achieved by developing a culture of openness, motivating and engaging people and by embedding knowledge management activities in business processes, internal systems and structures.

Factors such as interpersonal trust, communication, information systems, rewards and organisational structure are positively related to knowledge sharing in firms (Al-Alawi, Al-Marzooqi, & Mohammed, 2007). In the absence of trust formal knowledge sharing practices are unable to encourage individuals to share knowledge with others within the same work environment (Ipe, 2003). Competitive environments have problems with knowledge sharing that arise out of trust related issues. Organisational silos and subcultures are barriers to knowledge sharing. If the culture of the organisation attributes power to those who are perceived to possess certain knowledge it creates individual barriers for knowledge sharing.

Top management support significantly influence knowledge sharing processes (Svetlik et al., 2007). Perceptions of management's support for knowledge sharing and a positive social interaction culture are both significant predictors of an effective knowledge sharing culture (Connelly & Kelloway, 2003). Benefits of a positive social interaction culture include employees who are more knowledgeable about their colleagues' potential for being knowledge sources, as well as employees who trust their colleagues and hence willing to share knowledge with them. Employees who feel engaged and identify with their organisation are found to collaborate better with others by sharing knowledge (Lin, 2007).

The knowledge creation process within corporate innovation and the subsequent use of this knowledge are linked to the firm's learning and unlearning processes (Zahra, Nielsen, & Bogner, 1999). Acquisitive learning occurs when a firm acquires and internalises knowledge that exists externally to its boundaries. Experimental learning happens largely internally and generates new knowledge that is distinctive to the organisation. A firm without the necessary capabilities to transform its knowledge into valuable products or profitable business models does not improve its performance (Jantunen, 2005). The acquired individual knowledge has to be converted into a transferable form and distributed internally so that it can be used in business.

An organisation's ability to effectively leverage its knowledge is highly dependent on its people. Leveraging knowledge is only possible when people can share the knowledge they have and build on the knowledge of others (Ipe, 2003). The whole organisation shares explicit knowledge and converts it into tacit knowledge for individuals. Knowledge sharing between individuals is the process by which knowledge held by an individual is converted into a form that can be understood,

absorbed and used by others. Employees who believe in their ability to share useful knowledge tend to have stronger motivation to share knowledge with their colleagues.

It is not only the firm's knowledge but also how it flows is crucial for sustaining innovative performance (Jantunen, 2005). The study shows that knowledge utilisation capabilities are indicative of the firm's innovative performance. Knowledge utilisation capabilities indicate how effectively it can exploit acquired knowledge in the form of new and improved products. Knowledge acquisition capabilities consist of processes and mechanisms for creating knowledge from internal and external sources.

A firm with a knowledge management capability will use resources more effectively and will be more innovative (Darroch, 2005). Effective knowledge management enables those within the firm to extract more from all resources available to it. Knowledge management plays an important supporting function by providing a mechanism to convert resources into capabilities. The process of external knowledge application is distinct from the processes associated with transferring external knowledge into the organisation (Bierly et al., 2009). Firms add new knowledge by building on their previous knowledge base. Some firms may excel at learning from outside sources but may not be adept at applying the knowledge to creating new products and processes.

Organisational facilitators are essential for effective knowledge management (Martín-de Castro et al., 2011). It requires specific tools and practices for enhancing knowledge exploration and exploitation and enablers like coherent cultural values combined with good organisational leadership. Organisations that have values which give importance to openness and trust are better prepared to orient behaviours of their employees to share more ideas and knowledge. These firms can be more innovative and show responsiveness to changes and new market opportunities.

6.3.1 Absorptive Capacity

The assumption behind absorptive capacity is that the firm needs prior related knowledge to assimilate and use new knowledge (Cohen & Levinthal, 1990). The external knowledge is transformed and combined with existing internal knowledge in order to develop new organisational capabilities and thereby influence firms' innovation performance. Psychologists suggest that prior knowledge enhances learning because the storage of knowledge is developed by associative learning in which events are recorded into memory by establishing linkages with pre-existing concepts. The prior possession of relevant knowledge gives rise to initiating associations and new linkages. Absorptive capacity represents the link between a firm's internal capability and external knowledge. "The ability of a firm to recognise the value of new, external information, assimilate it,

and apply it to commercial ends is critical to its innovative capabilities. This capability is called a firm's absorptive capacity and it is largely a function of the firm's level of prior related knowledge."(Cohen & Levinthal, 1990).

Most important determinants for absorptive capacity are internal R&D, training of personnel, innovation co-operation and attitude toward change (Murovec & Prodan, 2009). Absorptive capacity is a by-product not only of R&D activities, but also of the diversity of the organisation's knowledge base, the existence of cross functional interfaces and problem solving capacity of the members (Camisón & Forés, 2010). Systems, coordination and socialisation capabilities of a firm are the main determinants of absorptive capacity (Van Den et al., 1999). Firms with higher levels of absorptive capacity will tend to be more proactive. Firms having a modest absorptive capacity will tend to be more reactive regarding exploring opportunities.

The higher the level of knowledge absorptive capacity the greater the innovation capability of the firm (Cohen & Levinthal, 1990). Firms must have a core capability for the maximum exploitation of existing knowledge and new knowledge by integrating this with existing knowledge. It determines how knowledge flows is transferred effectively between members of organisation networks. Knowledge equilibrium of networks depends on the size of network, knowledge transfer speed, and disseminative and absorptive capabilities of the entities in the network (Mu, Tang, & MacLachlan, 2010). Knowledge transfer requires a collaborative effort on the part of both knowledge senders and recipients. Efficient knowledge transfer requires strong disseminative capacity of knowledge senders and absorptive capacity of knowledge receivers.

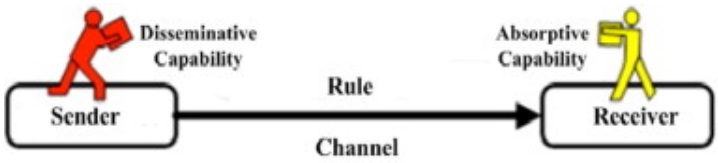

Figure 6-4 Knowledge transfer model in intra-organisational network (Mu et al., 2010).

Accumulated prior knowledge enhances the ability to assimilate knowledge related to the existing knowledge base. Knowledge diversity facilitates the innovation process by enabling the individual to make new associations and linkages (Cohen & Levinthal, 1990). The development of an organisation's absorptive capacity depends on the cumulative development of its individual's absorptive capacities. It depends on transfers of knowledge across and within the firm. The ability of organisations to implement complementarities between internal and external absorptive capacity routines can explain why some firms are successful early adopters and others are imitators (Lewin, Massini, & Peeters, 2011).

External knowledge inflows are directly related to absorptive capacity and indirectly related to innovation (Kostopoulos et al., 2011). Access to complementary external knowledge helps firms to begin question and update the existing knowledge and increase their ability to exploit and create new knowledge. Absorptive capacity permits firms to identify more available knowledge flows and acquire them. Innovation benefits are derived only if the firms recognise the value of new knowledge and exploit it.

There is a positive and significant relationship between absorptive capacity and innovative effort (Nieto & Quevedo, 2005). Those firms presenting a higher level of absorptive capacity can use knowledge generated by other companies and hence have a greater ability of innovation success. The determinants of absorptive capacity differ with respect to the type of knowledge absorbed for innovation activities according to Schmidt (2010). Results suggest that absorptive capacity is path dependent and firms can influence their ability to exploit external knowledge by encouraging employee's involvement in innovation projects.

Absorptive capacity consists of four distinctive but complementary organisational learning processes: acquisition, assimilation, transformation and exploitation (Zahra & George, 2002). Acquisition is a firm's ability to identify and acquire external knowledge that is important to its business. Assimilation refers to routines and processes that the firm uses to analyse, interpret and understand the acquired knowledge. Transformation refers to a firm's ability to combine existing knowledge with newly acquired expertise. Exploitation refers to a firm's ability to exploit existing and transformed knowledge into its operations.

Absorptive capacity has two dimensions namely potential absorptive capacity and realised absorptive capacity (Leal-Rodríguez et al., 2014). Organisational mechanisms associated with coordination capabilities enhance a firm's potential absorptive capacity (Jansen et al., 2005). Organisational mechanisms associated with socialisation capabilities increase a firm's realised absorptive capacity.

To be able to set up a broad knowledge base, a firm has to absorb information from different sources. Development of a closer relationship with external actors is crucial for absorptive capacity (Lund Vinding, 2006). Firms that are able to utilise and assimilate sophisticated knowledge by collaborating with knowledge institutions will have better competitive advantage. Collaboration with universities for research leads to superior search for new inventions and provides advantage in terms of quality of outcomes (Fabrizio, 2009). Basic research performed internally by the firm creates a foundation which improves the vocabulary of communication between the firm and the

university. This common knowledge base assists in effective knowledge transfer between the university and firm researchers.

The extent to which the firms make use of technological opportunities will depend for the most part on the knowledge and capacity of each business (Nieto & Quevedo, 2005). Firms not attaining the minimum critical mass of knowledge will not be able to enjoy the advantages of belonging to an environment of great technological opportunity. The presence of absorptive capacity is necessary for the effective utilisation of technological opportunity.

Absorptive capacity theory of knowledge spillover entrepreneurship argues that the level of knowledge spillover entrepreneurship depends not only on the speed of knowledge creation but also on entrepreneurial absorptive capacity (Qian & Acs, 2013). Entrepreneurial absorptive capacity is defined as the ability of an entrepreneur to understand new knowledge, recognise its value, and subsequently commercialise it by creating a firm. It has two dimensions which involves the scientific knowledge the individual should have in order to understand the new invention and its market value.

Knowledge input, knowledge spillover effect and knowledge absorptive capacity are positively related to innovation performance (Martín-de Castro et al., 2011). The concept of absorptive capacity is advanced by defining it as the multiplication of knowledge input and knowledge spillover effects.

6.3.2 Knowledge spillover

Knowledge spillover occur when knowledge produced by a given actor contributes to the knowledge creation or innovation of other actors (Greunz, 2005). The assumption is that the creation of new knowledge has positive external effects. New knowledge is created and diffused through innovation which expands the economy's potential to develop new products and services. Firms that innovate by adopting the innovation can benefit from knowledge spillover.

International knowledge spillovers enable firms to access the knowledge accumulated by others and to catch up (Ramadani et al., 2017). More new knowledge will be created with innovation which in turn results in more knowledge spillover. Knowledge spillovers and skilled workers have positive and statistically significant impact on the performance of firms. Firms are unable to benefit from innovation if their international activity is below a threshold level (Kafouros et al., 2008). Internationalisation can also advance innovative capacity by improving the process of knowledge accumulation and by increasing organisational learning.

Knowledge spillovers have a positive impact on firm innovation and on the probability of firms engaging in inter-organisational collaboration. If there is knowledge spillover, collaboration will be more effective than in other situations (Martín-de Castro et al., 2011). While one firm innovates, other firms may use the knowledge embodied in that innovation in their own activities. New firms and employees' mobility provide exchange and combination of knowledge resources and innovation capacity of firms depends on the effectiveness of knowledge transfer mechanisms.

Innovation is essentially a collective process where internal knowledge in the firm is combined with external knowledge and local knowledge spillovers play an important role. Firms can use both local knowledge spillovers and collaborations to compensate for a lack of internal competencies (Grillitsch & Nilsson, 2015). Innovative firms use inter-regional collaborations to compensate for a lack of opportunities to access local knowledge spillovers. Those industries with a greater investment in new knowledge exhibited higher start-up rates while those industries with less investment in new knowledge exhibited lower start-up rates (Audretsch & Lehmann, 2005).

Tacit knowledge is frequently accessed through entrepreneurs' and employees' past experience. Creation of new start-up firms in spin-off processes and employee mobility inside the regional and national innovation ecosystems are key factors for knowledge spillover (Xavier Molina-Morales & Teresa Martínez-Fernández, 2006). Start-up firms are founded either by a researcher who has worked previously in research institutions or by employees of firms that operate in similar technologies.

The mobility of R&D workers has a positive impact on firms' innovation output (Braunerhjelm, Ding, & Thulin, 2018). Small firms are highly dependent on workers from firms that previously have been engaged in innovation. Trippl and Maier introduced the concept of knowledge spillover agents (Trippl & Maier, 2011). They are Individuals who transfer knowledge from one place to another by means of their mobility. They bring their knowledge to other places, acquire new knowledge in the new place and thus promote new combinations of knowledge. The mobility of knowledge workers has a strong positive effect on firm innovativeness. Removing obstacles and facilitating intraregional mobility can enhance distribution of knowledge and strengthen spillovers from knowledge networks.

Globally engaged firms generate more patents and innovations and use more inputs to knowledge production. They use more researchers and knowledge inputs from outside the firm and within the firm. Globally engaged firms generate more innovations that gives higher productivity mainly because they learn more from diverse sources (Criscuolo, Haskel, & Slaughter, 2010). Another fact

is that business R&D and university R&D fuel each other, suggesting the existence of intra-regional knowledge spillovers among the actors involved along the innovation process. Government R&D feeds both business R&D and university R&D. Absorption capacity is a necessary condition for a region to capture knowledge created elsewhere and to benefit from knowledge spillovers.

Knowledge spillovers constitute an important factor in shaping the regional conditions for innovation activities (Fritsch & Franke, 2004). Regional innovation systems are based on the idea that innovations are the result of market motivated R&D efforts by a set of interrelated private and public actors (Greunz, 2005). This set of actors is composed of universities which develop new scientific knowledge, innovative firms that transform these technologies into innovation and the government which provides R&D support.

Universities play a key role in providing spillovers by academic research and human capital. It has been found that universities in regions with a higher knowledge capacity and greater knowledge output generate a higher number of technology start-ups (Audretsch & Lehmann, 2005). Empirical evidence suggests that those universities with a greater investment in knowledge and where the regional investment in knowledge is higher, tend to generate more technology start-ups. This supports the view that the spillover theory of knowledge holds for regional contexts as well as for industries.

The impact of academic research on regional innovation is determined by geographical proximity and networks of university industry collaboration (Ponds, Oort, & Frenken, 2009). Knowledge spillovers through research collaboration can occur over long distances. Academic knowledge spillovers occur between regions through geographical proximity and research collaboration networks. Collaborative networks between universities and firms form an important mechanism for academic knowledge spillovers in science and engineering based industries. In these industries knowledge spillovers are not bounded by any geographical limits.

The sources of knowledge spillovers are not only limited to geographically close clusters but also include distant actors. Distant sources of knowledge can contribute even more to the creation of local knowledge (Kang & Dall'erba, 2016). All types of spillovers play a significant role in the production of knowledge, although their relative impact depends on their type, source and location. Intraregional spillovers and distant interregional spillovers provide greater returns than those based on localised spillovers especially in the case of New Zealand firms.

6.4 Summary

Creativity and innovation will flourish only under the right circumstances. Values, norms and beliefs can either support or inhibit creativity and innovation and can influence individual and group behaviour. While some of the norms will permeate the entire firm, different groups within the firm might develop their own subcultures which creates silos. Flexibility values foster a culture of experimentation and empowerment while control values may set boundaries that facilitate management and evaluation. Ambidexterity or the ability of a firm to simultaneously explore and exploit enables a firm to adapt over time. An environment that is flexible, empowering, welcomes ideas, tolerates risk, celebrates success, fosters respect and encourages creativity is crucial to innovation. Openness in communication and trust factor are important elements which could positively change the organisational culture.

National culture and organisational culture have a profound influence on the level of entrepreneurship and innovation in firms. Innovation is more likely to occur if a society is less hierarchical. Innovation policies in individualistic cultures should be designed to provide support for collaboration and engagement with other firms. Innovation mindset needs to be ingrained as part of the organisation's culture. There is positive relationship between an individual's mindset and the organisational culture in which the individual is embedded. A growth mindset will create an atmosphere of creativity and learning. A collaboration mindset enables employees and managers to realise the significance of networking and to overcome communication and cultural barriers. Ecosystem mindset is an understanding that the organisation is not a bounded entity but part of a wider ecosystem.

Collaborating firms can improve the pace of innovation by having complimentary resources and capabilities. To facilitate external collaboration, it is important that the organisation has internal collaboration culture in place. Collaboration capability helps to build and manage network relationships with mutual trust, communication and commitment. Diverse teams outperform homogeneous teams by bringing a broader spectrum of knowledge and experience to the group. Employee engagement positively impacts the employee innovativeness and create the groundwork for innovation and creativity in the firm. Internal interactions within each firm will shape the external partnership and vice versa.

Universities can help with the free flow of information throughout the innovation ecosystem where ideas and insights can be shared, discussed and debated. Universities can serve as a source of refocusing on promising opportunities to prevent a declining ecosystem from becoming obsolete.

Trust is important in facilitating university–industry collaboration. R&D intensity, firm size and the regional industrial environment are important factors in the tendency of firms to use universities in their innovative activities. Open innovation is a novel business model based on harnessing collective creativity through collaboration. Open Innovation requires a firm to have a relook on organisational structures and management systems as well as on the culture, values and resources. It is enabled by collaborating with universities, buying and selling IP or start-ups that are extending the boundary of the industry.

Knowledge sharing and collaboration facilitate the cross fertilisation of ideas and enhanced creativity. Organisations can create synergies by enabling network participants to build on complimentary skills and capabilities. Employees who are actively encouraged to share ideas, take risks and initiate change are more inclined to be successful at inter firm collaboration. Organisation culture is positively related to the firm's knowledge sharing environment. In a culture that has a high level of trust, people are more likely to collaborate with each other and share knowledge. Knowledge sharing is enhanced by a culture where the role of knowledge, knowledge management, innovation and creative thinking is encouraged. Organisations that have values which give importance to openness and trust are better prepared to orient behaviours of their employees to share more ideas and knowledge.

Firms add new knowledge by building on their previous knowledge base. Absorptive capacity represents the link between a firm's internal capability and external knowledge. Firms with higher levels of absorptive capacity will tend to be more proactive. Efficient knowledge transfer requires strong disseminative capacity of knowledge senders and absorptive capacity of knowledge receivers. Those firms presenting a higher level of absorptive capacity can use knowledge generated by other companies and hence have a greater innovation success. Absorption capacity is a necessary condition for a region to capture knowledge created elsewhere and to benefit from knowledge spillovers.

Knowledge spillovers have a positive impact on firm innovation and on the probability of firms engaging in inter-organisational collaboration. Firms can use both local knowledge spillovers and collaborations to compensate for a lack of internal competencies. Universities play a key role in providing spillovers by academic research and human capital. Knowledge spillovers through research collaboration can occur over long distances. In science and engineering based industries knowledge spillovers are not bounded by any geographical limits. Innovative firms use inter-

regional collaborations to compensate for a lack of opportunities to access local knowledge spillovers.

7.0 Discussion

This chapter will discuss about the internal and external interactions within the three factors of culture, collaboration and knowledge sharing which appeared critical from the participatory action research on the New Zealand firms. It will also discuss about the effect of national innovation ecosystem and its influence on the regional and firm level systems. According to the observations and the collected data the three factors could form a virtuous cycle and one could affect the others and the relationship is dynamic in nature. Out of the three factors, culture is found to be more fundamental, and which requires the maximum attention while talking about the innovation ecosystem. But we also found that creating collaboration and an atmosphere for knowledge sharing can positively affect the culture in an organisation. Both collaboration and knowledge sharing are mutually linked and can work together to influence culture and vice versa.

The case study firms were subjected to external interactions and these were found to be beneficial in creating the circumstances for a dynamic innovation ecosystem. Bringing in external knowledge and collaboration partners had a positive change on the organisational culture and mindset. This in turn improved internal collaboration and knowledge sharing. Hence a virtuous cycle is formed which is more open towards external interactions. Rather than focusing on changing the firm culture through training and management methods this external intervention is found to be more effective. These interactions also proved that it is possible to create an internal innovation ecosystem in firms along with them being part of an external ecosystem.

The Auckland regional innovation ecosystem appears to be less dynamic, and many actors are not proactively engaging with others. University of Auckland and other universities in the region haven't fully utilised the knowledge sharing and collaboration potential of the local firms. There is a huge missed opportunity for cooperation and working together and it shows the lack of ecosystem mindset on the part of either sides. Cultural, aspirational and mindset related barriers are preventing real collaborative innovations. The lack of absorptive capacity of firms is another reason for the inhibition in knowledge sharing activities. Knowledge spillover effect is also lacking in the New Zealand ecosystem and Auckland regional innovation ecosystem.

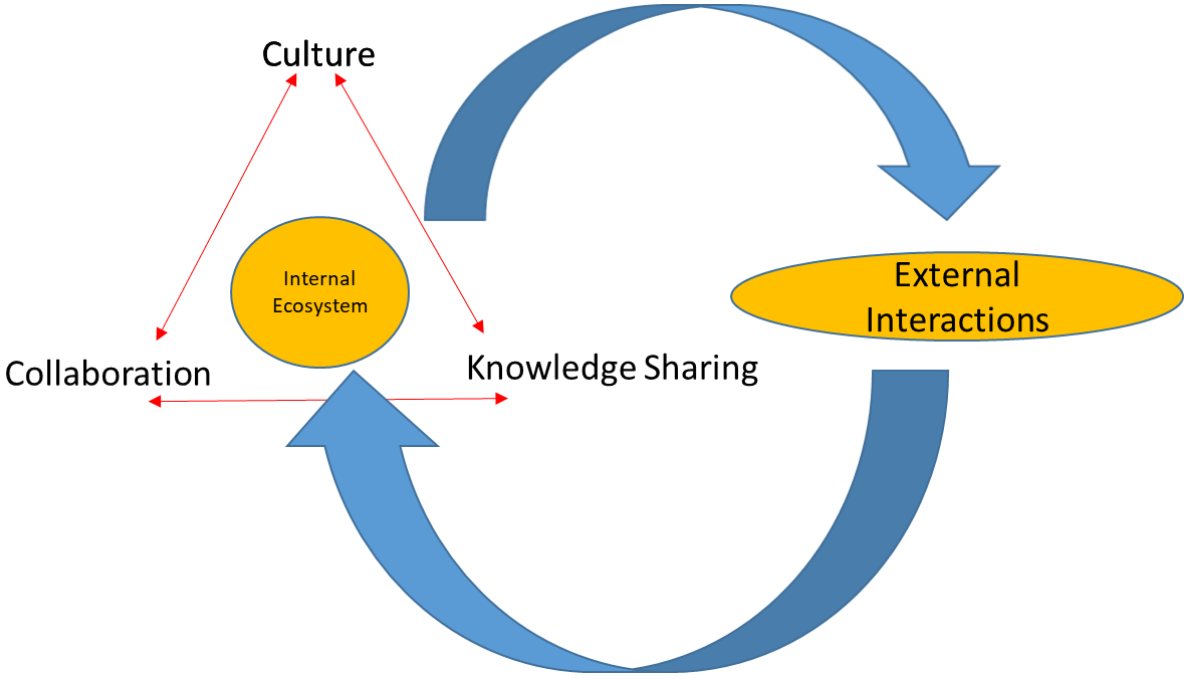

Figure 7-1 Positive external interactions and its effect

It is found that external interactions can positively influence the internal innovation ecosystem in firms as shown above in figure 7-1. Interactions tend to force the firms to look at possibilities and have an open minded approach to accommodate the broader outlook. This was evident in the university-industry interactions where the student led teams come up with ideas to solve the organisations issue. It challenged the conventional thinking in the firm and brought in fresh perspective. Another example was when case study firms engaged with its supplier in collaborative innovation and sharing of its expertise. In all these cases the formation of a network of interaction patterns could be visible.

The two firms studied as part of the case study were from traditional sectors namely transportation and logistics. New Zealand does not have any research institutions in these areas and very limited research is happening within universities. The only way to overcome this is to have proper R&D in the firms or to engage with international partners. New Zealand firms do not have reasonable R&D spend and the interaction with global entities is also limited. Industry networks and supply chain partners are the only outside exposure.

Lack of time, motivation and resources for innovation, incentives not helpful to reward innovation and lack of innovation process are some of the barriers for innovation as seen in the case study firms. Innovation activities are getting less priority among the day-to-day operational challenges of the business. This was visible in the case study firms as well as in other ecosystem partners. The lack of innovation strategy and leadership is one of the main causes for this. The low aspiration level

at the firm as well as at the regional and national ecosystems could affect the general motivation for innovation.

Firms need to catch up fast in many areas of technology and operations to become world class organisations. More often legacy technology systems and processes are taking away valuable productive time which could otherwise be used for creative and innovative activities. Traditional mindset and not investing enough in technology solutions could be some of the reasons of not achieving the innovation threshold. This issue appears to be a countrywide phenomenon since New Zealand firms spend less on capital investment and that is bringing the productivity down in the country.

Firm level innovation often consists of marginal improvements in process or products rather than significant technology adoption or market creating innovations. There is a general tendency to focus on small improvements and not touch areas which require radical thinking and effort. Risk perception and cultural factors could be cited as reason for this type of thinking. Competition landscape of the country makes it less desirable for firms to make radical market creating innovations their focus. Only among export oriented firms we could see market creating innovations. And even then, the scalability is a challenge. The solution is to have lots of export oriented, market creating innovation firms in niche areas.

Firms need structures, processes and tools for knowledge creation and utilisation. Knowledge management is a systematic process of coordinating activities of acquiring, creating, sharing and deploying knowledge in a firm. The case study firms were lacking a proper knowledge management system. They also lacked a social atmosphere which brings together employees of diverse abilities to share their expertise and knowledge. Knowledge sharing and collaboration involves social and human interaction. A culture which promotes open communication increases people's opportunity to interact with each other and enhance knowledge creation. The belief in the good intentions of other people facilitates cooperation which increases trust.

Hierarchical structure in management and conservative decision-making processes are still prevalent in the case study organisations. There appears to be a communication gap between different levels of management. This prevents alignment of objectives and have an effect on knowledge sharing and collaboration within the firm. On a national scale, government policies also show a lack of focus to make New Zealand a nation of knowledge and innovation. There is a gap between what the government promises and what is delivered on the ground. This affects regional level innovation ecosystem and firm level innovation dynamics.

7.1 Cultural Effects

The most important factor influencing innovation in a firm or in an ecosystem is culture. Organisational culture and mindsets have a big role to play in shaping the innovation readiness and the right conditions for future growth. The way things are done, the value system and norms have a huge bearing on people's approach to innovation related works. The national culture and its effect on regional and organisational level is well evident from the studies that are done at the case study firms as well as from the literature. Changing the mindset, unlearning and relearning and having a growth mindset are important elements for developing an innovation culture.

Employees' mindset has an impact on the trust factor, the sense of empowerment and commitment and on the level of collaboration and innovation of the firm. Under a fixed mindset we believe that there are a finite set of smart people and valuable resources available outside the company. Those firms which have a growth mindset have employees who show far more trust in their firm and a much greater sense of ownership and commitment. They will have more positive views of their organisation and are ready to come up with innovative ideas which will help the firm stay competitive.

A growth mindset is a belief that through effort, learning and persistence we can adapt our character, intelligence and skills over time. Previously, it was believed that our brain structure was fixed once it was fully developed, and we were unable to grow new brain cells. However, a growing body of research shows that through learning, effort and applying a growth mindset we can change our brain's synaptic connections through a process called neuroplasticity. Being aware of the existing mindset, strengths, weaknesses and biases is the first step in developing a growth mindset.

Values represent a more visible manifestation of culture that signify beliefs identifying what is important to a particular group. Cultural values such as sharing, openness and trust will lead to positive behaviours that will lead to innovation and efficiencies. The Kiwi "number 8 wire" mentality shows that people are more independent and sometimes lack the sharing culture. A culture which encourages open communication, experimentation and risk taking and motivates employees to question fundamental beliefs and thinking patterns will positively improve the organisational learning capacity and hence knowledge sharing and collaboration.

Culture influences the way each of the different ecosystem's actors develops an innovation and engage with other partners (Rabelo & Bernus, 2015). Each actor involved has its own individual approach and intrinsic character and goals in the ecosystem. Hence, it is difficult to design a

common framework through which different actors interact and share their knowledge. A holistic approach is needed to get the maximum leverage out of the innovation ecosystem.

Firms tend to follow what has worked in the past even though this may not always be the right approach. Individuals can be resistant to new approaches to doing things as they fail to question and unlearn existing assumptions and routines. Inability to break through the barriers of conventional thinking hinders innovation (Assink, 2006). Research shows that employees become more receptive to innovative ideas and create space for new learning when unlearning precedes these processes (Klammer, Grisold, & Gueldenberg, 2019). Organisations need to understand that knowledge can become outdated, and they need to discard it. The ability to unlearn is one of the most critical competencies people require for disruptive innovation.

Silos were found to be prevalent in both the study organisations. Silos created subcultures and acted as inhibitors to knowledge sharing and collaboration. Through external interactions some of these silos were linked and therefore it positively affected the internal dynamics of the firm. Silos negatively affect external interactions too. Some teams were found to be more open towards external interactions while others were having a closed mindset. It has to do with the subcultures within the organisational structure. Overall, we find that the external intervention has linked the silos and improved better communication and sharing of knowledge in the firm.

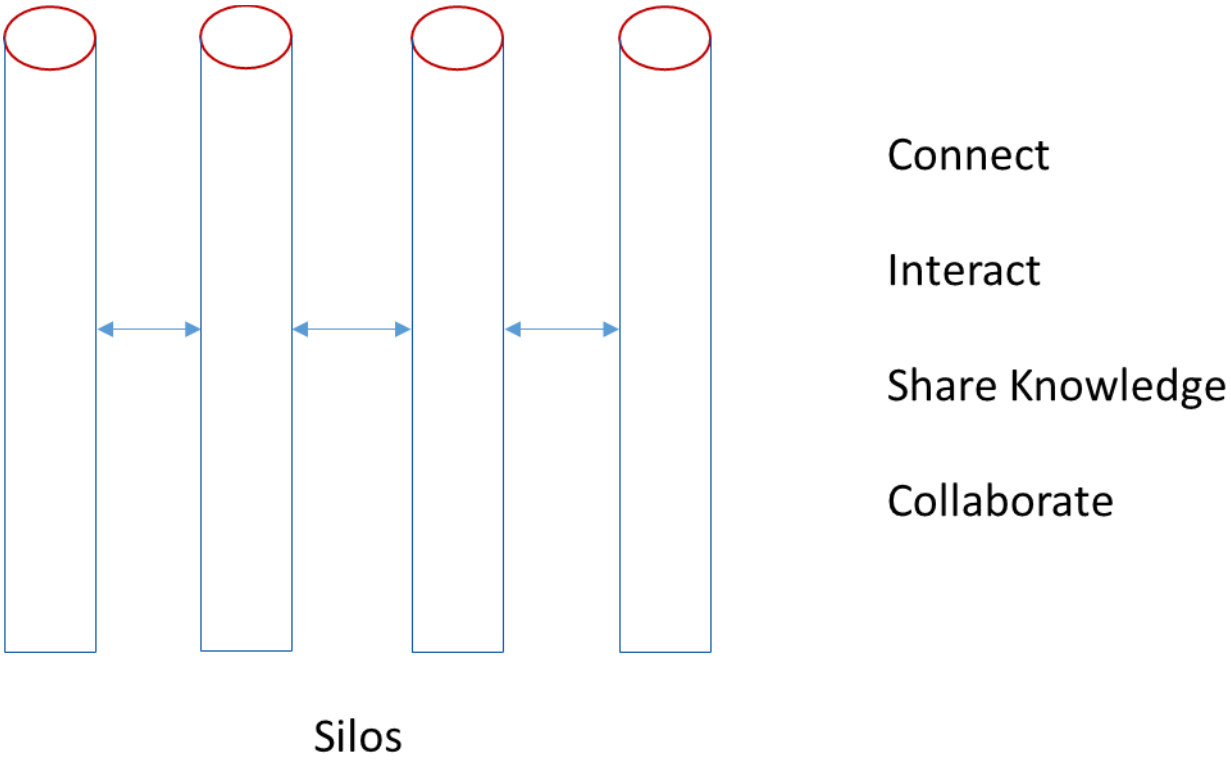

Figure 7-2 Silo effect in an organisation can be addressed proactively

Silo effect is also mentioned in several studies on the New Zealand innovation system. Research organisations and many other actors in the innovation ecosystems are found to be competing against each other rather than cooperating. Competition for government funding is one reason for it. But the major reason is not having a holistic picture of the innovation ecosystem and understanding their role in it. Culture and mindset related reasons are also relevant. The solution is to connect, increase interactions, initiate sharing of knowledge and to promote collaboration between silos as shown in the figure 7-2 above.

Cultural factors are the hardest to change in a firm. Even with external interactions like collaboration or knowledge transfer the core culture in the firm has a very little change effect. In fact, the strong grip of cultural factors was seen to be one of the main reasons the firm resists interaction with external innovation ecosystem. It affects the intention and motivation for collaboration as well as work against receiving and sharing knowledge with others.

Cultural factors have different dimensions starting with the personal level to the firm, industry, regional and national levels as shown in figure 7-3. This effect goes both ways: from the individual to the organisation, regional and national, and the other way in which a national culture having an effect on citizens. The value framework in the firm has a big impact on the company culture. Changing the processes and values in an organisation is not easy. Aspiration level and the scale of motivation depends on overall cultural effect. The way each individual perceives their firm and the ecosystem has a greater impact on other factors like collaboration and knowledge sharing.

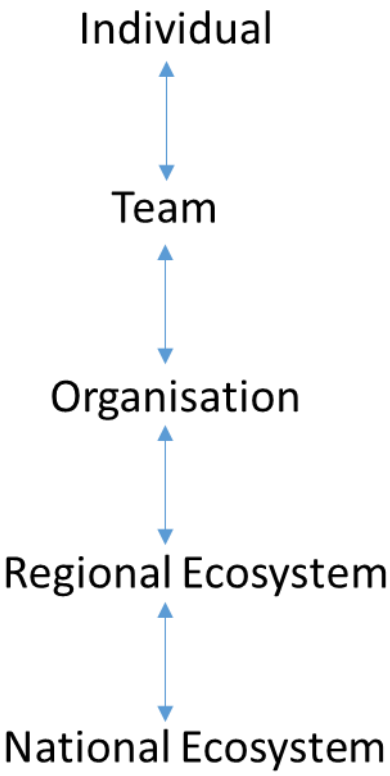

Figure 7-3 Innovation and the different layers of culture related effects

Organisational culture is not homogeneous and there are always subcultures which might be different from the organisation as a whole. Even in organisations that strongly support sharing knowledge there could be pockets that were less supportive. The visible dimension of culture is reflected in the values and mission of the firm while the invisible dimension lies in the unspoken set of values that guide people's actions and perceptions in the organisation. In order to instigate new culture styles and behaviours, a firm's systems and processes need to support aspirational culture and strategy.

Knowledge based organisations of today have their success depend on creativity and innovation. Organisational culture that supports a continuous learning should encourage creativity and innovation. A culture which encourages open communication, experimentation and risk taking and motivates employees to question fundamental beliefs and thinking patterns will positively improve the organisational learning capacity.

The value of innovation as an organisational strategy will lead to a culture which is supportive to different kinds of innovations. Conservative attitudes mean that there is less incentive to come out with a novel idea that will be possibly rejected. In open societies employees have more opportunities to try something new. Firms need to adopt flexible structures that give people the freedom to experiment and to be creative. At the firm level, efforts of cultural change toward more

entrepreneurships can start a virtuous cycle which makes the organisational culture more and more innovative.

Research shows that one of the main reasons why firms fail to initiate change and drive innovations is the inability to unlearn (Klammer et al., 2019). Unlearning is defined as the process by which people and firms eliminate old thinking pattern and embrace the change. This inability to discard obsolete knowledge will lead to rigidity and stagnation. It is important to unlearn obsolete or outdated mental models before individuals or firms can have new learnings.

The development of corporate entrepreneurship and innovation require an organisational culture and a management style that are innovation focused. Cross-functional thinking and empathetic mindset which stresses the needs of the end user are other behavioural considerations needed for innovation. Innovation has a positive impact on company culture as it increases the ability to acquire, create and share competencies, skills and knowledge. Innovation practices can help build a culture of agility, learning organisation, growth mindset and personal development.

7.2 Collaboration and Knowledge Sharing

Innovation requires interaction between different entities; people, teams, firms, supply chain partners and outside organisations. Organisations which are better positioned to draw upon ideas, resources and support from other outside entities can do more effective innovation((Ahuja, 2000);(Porter & Kramer, 2011)). Collaboration with multiple parties can help increase the pace of innovation and its sustenance. Clusters and innovation eco systems enable this interaction in a geographical location. The same interactive dynamics can be set up inside an organisation to create the right conditions for innovation.

Firms that collaborate for innovation with others are reducing the risk of bringing an innovation to market. Interpersonal trust or trust between co-workers is an extremely essential attribute in organisational culture which have a strong influence over collaboration and knowledge sharing. The basic requirement for participation in ecosystems is a high level of trust in the other actors in the system as well as shared values and aspirations of the participating companies. Hence, it is important for organisations to cultivate an atmosphere of trust and have good communication with its employees.

One way to survive and succeed in the innovation ecosystem is to be an attractive collaboration partner. The results of collaborative innovation in ecosystems appear from the dynamics of interaction between actors. These interactions occur within a firm as well as between firms and

other ecosystem partners. There is a need for collaboration champions in the industry and people dedicated to maintaining and nurture relationship with outside firms.

Employee willingness to share knowledge enable the firm to improve innovation capability, sustain innovativeness and position the firm in terms of long term competitive advantage. Empowered employees spend greater efforts on group work and contribute more towards knowledge sharing. Firms need to increase their collaboration capability in relation to alliances, cross-functional teams, intra-firm cooperation and open innovation. Companies can make greater use of external ideas and technologies in their own business and let unused internal ideas and technologies go outside for others to use in their business.

Collaboration and knowledge sharing between entities require some fundamental characteristics in place such as communication and trust between parties. Perception of value is also important. If either party do not see the value generated by the collaboration it will cause a failure in engagement. This is in fact one of the major causes for collaboration failures. Knowledge sharing is successful only if the absorptive ability of the receiving party is able to grasp the knowledge and make use of it. Knowledge spillover is more for complex industries like aerospace or high-tech manufacturing compared to traditional industries like farming, diary or tourism.

In the firm level, high levels of internal and external organisational integration are necessary to attain maximum competitive advantage. Inter-unit collaboration in big firms contributes to learning, develop capabilities and respond to changing business models and disruption in technologies (Hansen & Nohria, 2004). Internal and external networks of knowledge sharing and collaboration are key factors in shaping the innovation eco system. Collaboration will open up the work culture in a firm and encourage a shift away from silos of functioning and create an atmosphere of knowledge sharing. This will enable exchange of ideas and encourage fresh perspective in thinking.

Knowledge management creates a culture in which the value of knowledge and application is appreciated. A knowledge sharing culture creates behavioural change towards creation, sharing and leverage of knowledge and hence creates a culture of innovation and creativity. Knowledge management systems have a significant contribution in the development of sustainable competitive advantage through innovation. Knowledge management also provides the processes to ensure knowledge creation and sharing within the collaborative firms. Every organisation should have a knowledge management system and incentives directed towards sharing of knowledge and expertise.

Knowledge exploitation is impossible for organisations if they do not previously acquire and explored new knowledge. If the firms lack the capability to transform and exploit acquired knowledge, they will be unable to create value. Knowledge sharing strategies and processes affect the intellectual capital of the firm. The combination of organisation culture, knowledge sharing and intellectual capital is of great importance in the development of a knowledge based organisation. To foster a culture for knowledge sharing, organisations will have to recognise the role of trust among employees.

Knowledge sharing and collaboration significantly influences corporate innovation performance (Martín-de Castro et al., 2011). Collaborative culture encourages the development of organisational learning and have a significant effect on performance of the firm (López, Peón, & Ordás, 2004). Knowledge management allows collaboration across functional boundaries within organisations, but also across organisational boundaries through online collaboration forums as well as tools and external online platforms. It also ensures that knowledge external to the organisation relevant to the innovation processes is available and accessible.

Building absorptive capacity and network connections result in a faster pace of innovation in firms. The concept of absorptive capacity shows that knowledge outside the boundaries of the firm is not equally absorbed and exploited by all firms. A firm's research and collaborations provide access to external knowledge that would otherwise be missed and allows researchers to identify and absorb knowledge more quickly. It is new knowledge and ideas created in one context but left uncommercialised, which is known as knowledge spillover, that serves as the source of knowledge generating entrepreneurial opportunities. The source of the knowledge and ideas may not be the same as the firm attempting to commercialise and derive value out of it.

7.3 Other Factors

Management techniques that are facilitative rather than directive, based on high trust and making the most of employee skills, can assist in lifting firm innovation. Organisational trust can be improved through social communication that complements official communication. When two partners begin to trust each other, they are more likely to share resources. For firms, cooperating with external researchers and innovators becomes an important method of developing their own business. Networks of mutual trust, common interests, shared values and narratives help sustain an environment of collaboration and knowledge sharing.

The conventional management principles fail to support innovation. The very decision making and resource allocation processes that are key to the success of established companies are the very processes that reject disruptive technologies (Christensen, 2013). This is one reason why organisations seek to form dedicated innovation hubs to kick start innovation and provide independence. This will prevent the undue interference of rigid organisational structure on the innovation process. This will also help the hubs to better manage risk and have financial freedom to undertake disruptive innovations.

Reward and recognition are also important to encourage people to participate in innovation. The feel that they are being recognised will encourage employees to come up with innovative ideas and also participate in commercialisation activities. Different ways of idea capture where there is participation from all parts of the firm is required. Online platforms for submitting ideas and offline collaborating workshops will go a long way in spreading the innovation story to all parts of the organisation.

Opportunity cost of not providing time for innovation related activities is high. When people are inundated with tasks then there will not be any space or time to think, discuss and generate ideas. Having a small percentage of time available to work exclusively on innovation related projects and making physical and online places to collaborate is required. Those organisations which provide time for innovation related activities which are not interrupted by daily operation specific tasks are found to be better prepared to facing competition and generating more value. Organisations which have a dedicated innovation hub and time for its employees to engage with innovation related activities are on the right path.

Exploration refers to the application of external knowledge to produce new products and technologies and exploitation refers to the application of the external knowledge to refine the firm's existing products and improve its processes (March, 1991). Exploration is associated with divergent thinking and exploitation is associated with convergent thinking. An organisation should function as an ambidextrous firm, simultaneously doing exploration and exploitation of knowledge. A certain percentage of budget must be spent on technologies based on future foresight and this investment should be independently pursued in spite of other challenges.

Preconceptions are synaptic pathways through our brains which screen how we encounter and make sense of observations (DeBresson, 1999). We always see things through pre-established perceptual lenses. Only active efforts to train ourselves and establish new synaptic pathways will

enable us to see things in new ways. We must rethink and analyse the innovation process as the outcome of networks of firms and the coordination process between them.

When the organisational structure is more centralised, the ability of employees to create and share knowledge is limited. Organisational structure levels (formalisation and centralisation) negatively influence knowledge creation, sharing and application. This was observed in the case study organisations and it created barriers between the upper management and the employees in terms of collaboration and knowledge sharing. It also negatively influenced the idea generation process and idea to commercialisation cycle in the firm. A crowdsourcing idea generation platform and suitable processes to bring those ideas to fruition is needed in organisations.

The innovative process follows a complex pattern of interaction. The productivity and effectiveness of the innovation system depends on the regional characteristics, the willingness to collaborate and the openness and degree of integration into the global economy. This was clearly visible while going through the participatory action research on the New Zealand firms. Cultural and mindset related interactions were more prominent followed by collaboration and knowledge sharing difficulties. Absorptive capacity and knowledge spillover related barriers were seen in national, regional and firm level innovation ecosystems. Those organisations which have an internal environment where collaboration and knowledge sharing is encouraged are found to be effective in external interactions and vice versa.

We found that there is a network of interactions happening at the firm level ecosystem, between the firm level and regional level, among regional ecosystem partners, between regional and national level ecosystem and within various partners in the national innovation ecosystem. We could also include the worldwide collaborations and knowledge sharing and expand the scope of this network. It is hard to grasp the overall effect of this complex system. The conclusions we can reach is that an increase in the network linkages is beneficial for innovation and there are several layers of synergy that is possible. In a globalised economy it is an advantage to have wider network of interactions.

7.4 New Zealand Innovation ecosystem

More studies on NZ innovation are undertaken to find the common tendencies of innovation in New Zealand. The two research case studies have given a deeper understanding about the innovation dynamics and the challenges involved in creating an innovation ecosystem within the firm. Another notable finding from the study of case organisations as well as the literature is different layers of innovation ecosystems and the interplay between those. The regional and

national innovation systems have a much larger role to play in giving the proper external environment where firm level ecosystems can flourish.

Innovation requires collaboration and sharing of knowledge. Flows of talent and knowledge must transcend firm and geographic boundaries. Successful firms achieve significant multiples for investment in innovation through accessing skills and talents of others. The best firms find ways to embed innovation into their culture and throughout the organisation (McKinsey, 2015). Organisational changes may be necessary to promote collaboration, learning and experimentation. Internal collaboration and experimentation can take years to establish in large firms with strong cultures and rigid ways of working.

Participants in the New Zealand innovation system are not very well connected among themselves. New Zealand founders score poorly relative to founders in other ecosystems in terms of the number of quality relationships they have with other founders, investors and experts (MBIE, 2019d). A small number of New Zealand institutions account for a large proportion of national collaborations (Arefkashfi, Friggens, & Hendy, 2018). The overall academic-corporate collaboration metric for New Zealand is the lowest among small advanced economies. The current incentive system for researchers and research institutions can encourage a less connected approach and pursuing of individual projects rather than connect more broadly between disciplines and institutions.

The level of expenditure in R&D in each country correlates strongly with its economic biomass which can be the number of patents in its innovation ecosystem (O'Neale & Hendy, 2012). The OECD suggests that about a third of the gap in productivity performance could be explained by a lack of investment in knowledge-based capital. Economies and firms that innovate do better over the long term. Economies with a diversified export basket are more innovative (GII, 2019). New Zealand has to diversify its export and include more value added products and services in its export kit.

New Zealand is ranked 26 on the Global innovation index ranking (GII, 2020). According to the report New Zealand produces less innovation outputs relative to its level of innovation investments. Figure 7-4 shows Bloomberg ranking of the world's most innovative economies based on R&D spending, patent activity, efficiency of tertiary education, value added manufacturing, productivity and researcher concentration (Bloomberg, 2020). The list shows the opportunity for small advanced economies to be the most innovative economies in the world by investing in STEM areas. New Zealand is ranked number 29 on the list which indicates the need for a more focused approach to R&D and innovation.

Figure 7-4 The most innovative economies in the world (Bloomberg, 2020)

Two main bottlenecks for innovation in New Zealand are a decline in the level and speed of innovation due to lower investments in research and development and uneven adoption of innovation across the economy (GII, 2019). The Productivity Commission identified that several New Zealand industries are disconnected from the global innovation frontier and that the country has a lot of unproductive firms in some industries (MBIE, 2019b). Increasing the level of innovation within existing firms is important for supporting key industries to add more value. Increasing the capital investment and automation can improve productivity but innovation is the surest way to improve productivity and economic growth. Innovative firms and sectors also tend to create highly skilled, well-paid jobs and go on to generate opportunities in other higher-value sectors.

Productivity is how economists measure the efficiency with which resources such as labour, capital and land are used to produce goods and services (Motu, 2020). A more productive use of natural resources can allow the same level of output to be achieved at a lower environmental footprint. Complementary skills are positively linked with productivity, innovation and growth. Strong connections to the innovation ecosystem will give exposure to diversity of ideas and improves market potential. Very few New Zealand businesses operate at the global technological frontier in their industry as shown in figure 7-5 below. New Zealand's labour productivity is around 40% below the average OECD benchmark (Productivity Commission, 2020).

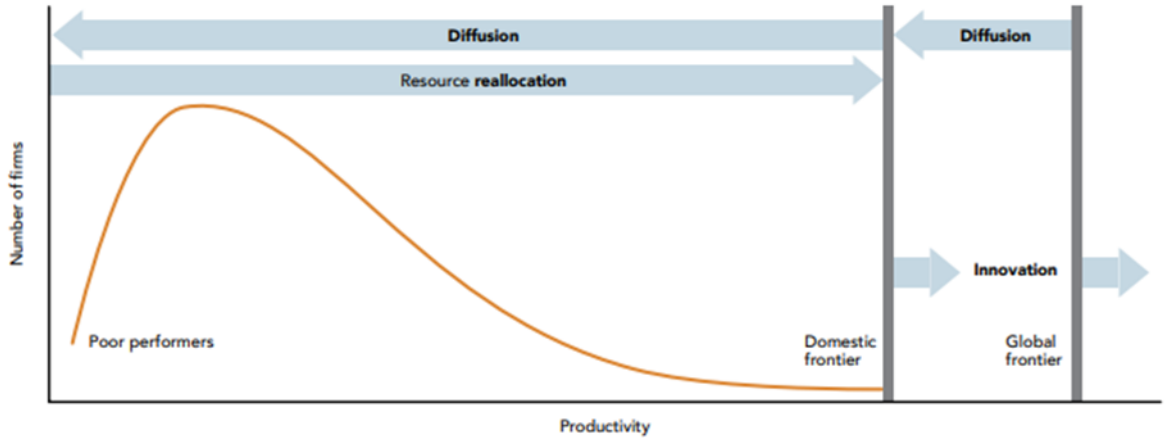

Figure 7-5 Reaching the productivity frontier (New Zealand Productivity Commission, 2021)

According to David Skilling (2020), understanding the productivity dynamics of small advanced economies can provide specific guidance for New Zealand in developing productivity policy. Firms in export sectors that scale into international markets are much more likely to be close to the productivity frontier. A healthy ecosystem of firms is required, from large MNCs to high growth smaller firms, as well as a mix of small and medium-sized firms. Firms need to be investing more in building the capabilities that will support innovation and international growth.

Private sector investment of New Zealand firms is one of the lowest among OECD nations. The scale of operations of the New Zealand firms is one reason for the lack of R&D spending. The other reason is the lack of competition domestically. The limited size and market potential do not motivate the firms to explore further. Ambidexterity is lacking and unless firms explore more there won't be anything to exploit for innovation and commercialisation. There needs to be a critical mass of ecosystem partners and linkages to form the minimum threshold for a flourishing innovation ecosystem. New Zealand hasn't reached this threshold and hence the ecosystem suffers.

New Zealand's poor productivity performance has been a persistent problem over decades and turning this around will require consistent and focussed effort for many years (Productivity Commission, 2019). There is a cultural impact of low spending on R&D by the government on the motivation of businesses to spend on R&D. This in turn affects the overall R&D and innovation culture at the national level as well as at the firm level. Staying ahead of competition and improving productivity needs R&D and innovation and New Zealand as a nation needs to focus its efforts on improving this. Government has to take the lead and show leadership and increase the R&D budget comparable to other small advanced economies.

Richard and Trinh show that absorptive capacity has a substantial influence on exporting, innovation, R&D and firm-level productivity (Harris & Le, 2019). New Zealand domestic firms have

the lowest levels of absorptive capacity. There has been limited policy assistance to build dynamic capabilities and improve absorptive capacity in the case of New Zealand. Hence firms are unable to gain from the knowledge spillover from other firms, research institutes, university research and international collaborations.

Successive governments have failed to give the right motivation for innovation and leadership which is required (MBIE, 2019b). New Zealand economic growth has been too dependent on house price inflation driving consumption and demand for extra infrastructure. Too much of capital has been directed towards properties rather than on growing competitive advantage. New Zealand has not consistently made the effort to create an environment in which people find it attractive to make the most of their talents and resources (2025 Task Force, 2009). What is needed is a structure which gives ecosystem players an incentive to collaborate, interact and exchange ideas so that an agile and adaptive ecosystem for research and innovation is created.

New Zealand's innovation ecosystems are not strong or focused enough to propel frontier firms into exporting at scale in areas of enduring competitive advantage. New Zealand performs poorly on various innovation measures and is trailing comparator SAEs in translating innovation into economic outcomes. New Zealand investment in R&D is quite low and there is lack of innovation strategy. Primary sector is still given the bulk of funding and priority as a result of the system wise conservatism. NZ government still spends a lot of money on primary industries while not giving the due importance to knowledge industries. The government policy framework can help in changing the NZ perspective from primary industries to more knowledge and technology industries.

7.5 Summary

We have discussed the right conditions for innovation ecosystems and how New Zealand firms can generate a synergy out of all the interactions with the internal and external ecosystems. A major part of the discussion focuses on the culture, collaboration and knowledge sharing aspects which are found to be essential for a dynamic ecosystem. Elements such as trust, communication, commitment, absorptive capacity and knowledge spillover were found to be the main characteristics for developing and sustaining the innovation ecosystem. Other major elements are the availability of time, resources and skills which are needed for innovation to happen.

A detailed discussion on the country effect is done to see how the New Zealand national characteristics have influenced the country wide, regional and firm level formation and dynamics of the innovation ecosystem. There is a huge amount of unused potential in the country because of the barriers in knowledge sharing and collaboration between different actors in the ecosystem.

There are cultural, geographical and aspirational challenges for the country whereas the firms have size, scale and market related challenges.

One major finding is the lower spending on R&D by both the government and the private sector. There is a cultural impact of low spending on R&D by the government on the motivation of businesses to spend on R&D. This in turn affects the overall R&D and innovation culture at the national level as well as at the firm level. For New Zealand to fully utilise its potential it definitely needs to invest more on R&D and also nurture a vibrant innovation ecosystem.

8.0 Recommendations

"Our future lies in the niches of a world economy 500 times bigger than our own."

Sir Paul Callaghan

The participatory action research on the case study firms showed that factors such as culture, collaboration and knowledge sharing are of prime importance while setting up an innovation ecosystem. These factors influence each other, and external interactions can have a positive effect on creating a dynamic internal innovation ecosystem. This positive interplay between internal and external innovation ecosystems are shown in figure 8-1. There is a synergetic relationship between external and internal ecosystems and this interplay is important for innovation and economic growth.

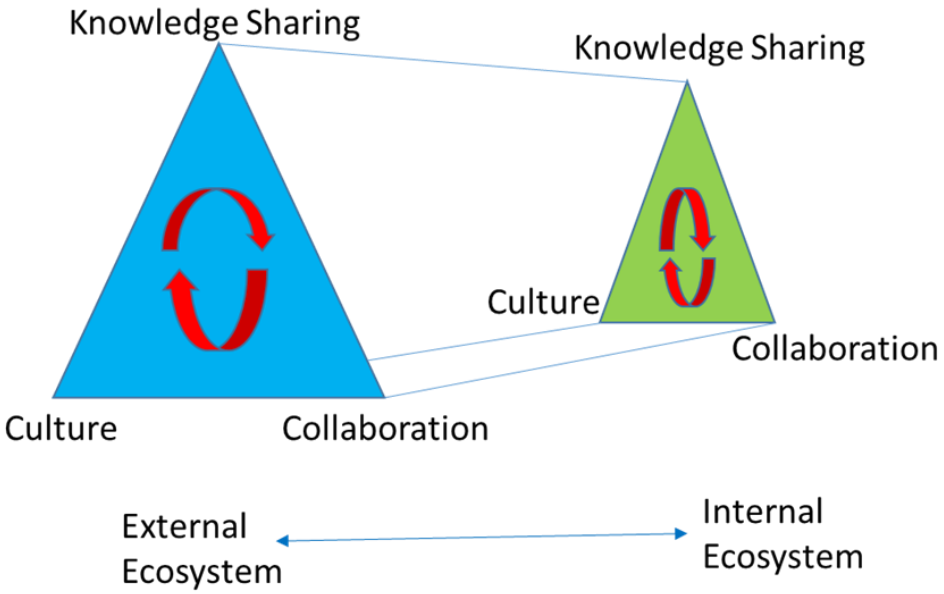

Figure 8-1 Interplay between external and internal innovation ecosystems

There is a greater scope for collaborative innovation between universities, research centers and industry. Knowledge spillover opportunity of big firms and universities need to be fully utilised by effective collaborative innovation partnerships. Transactional level partnerships need to progress to collaborative level engagements. Increasing the flow of people and partnerships between academia and industry should promote mutual understanding and identify opportunities for new ideas to develop and grow.

8.1 Elements of innovation ecosystem

A high level of trust is required for the future of the collaboration. Organisational trust and collaborative culture are positively associated with team creativity (Barczak et al., 2010). Cognitive trust enhances creativity by moderating the relationship between collaborative culture and team creativity. When team members trust each other to be competent and reliable, they are more open to diverse viewpoints leading to an even more creative solution. During the project development process partners have to share complimentary knowledge and competencies. The trust level must be very high to guarantee that the result of the project will be beneficial for all partners.

Inter-organisational trust is the main enabler for lowering the barriers to interaction between universities and industry. Industry collaboration not only facilitates the transfer of knowledge and accelerates the exploitation of new inventions, but it also increases academic research output. A purpose-driven university is one that asks itself why it exists and seeks to support its faculty and students so that they can have a positive effect on society far beyond monetary measurements. The prominent university at the region can help create preconditions by ensuring a research and outreach presence in promising technological fields with regional potential.

From the case study observations and data, as well as the literature shows there needs to be some fundamental elements to create a dynamic innovation ecosystem in a firm. The main elements are trust, communication, absorptive capacity, knowledge spillover and commitment. The degree and individual effect of these elements are beyond the scope of this study. But the interactions are quite clear and through management intervention and leadership it is possible to create a thriving innovation ecosystem. The positive interplay between internal and external ecosystem factors are facilitated by the foundational elements such as trust, communication, commitment, absorptive capacity and knowledge spillover and its effect on the fundamental factors of culture, collaboration and knowledge sharing.

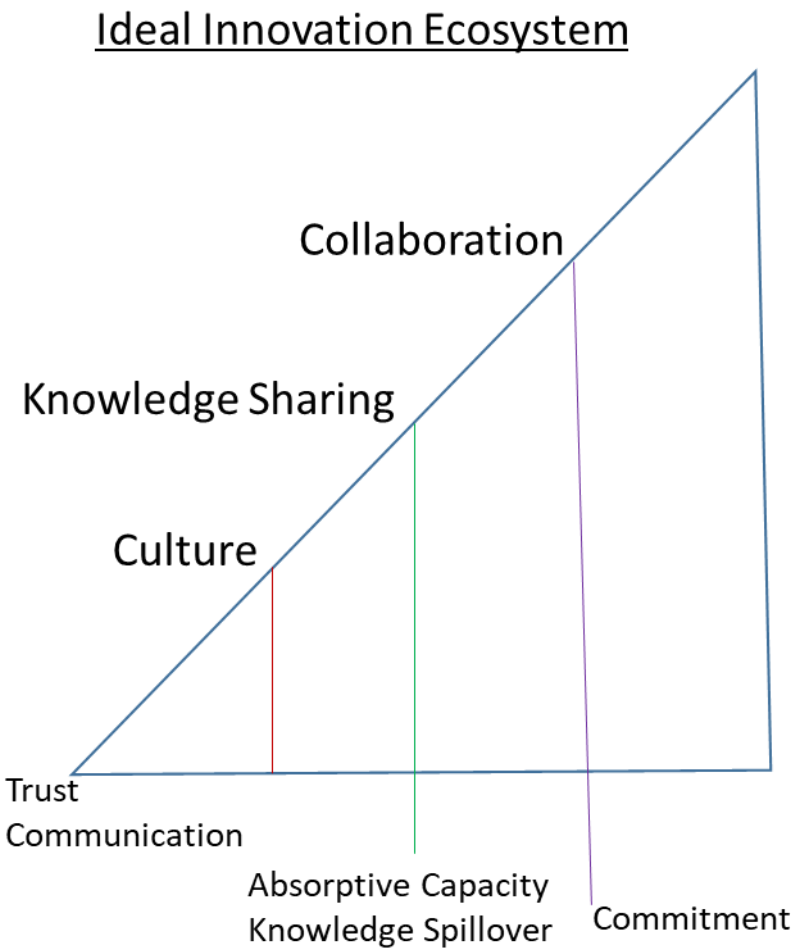

Figure 8-2 Ideal Innovation Ecosystem

Trust and communication are the fundamental elements of the three factors of culture, collaboration and knowledge sharing as shown in figure 8-2. Absorptive capacity and knowledge spillover affect knowledge sharing as well as collaboration. Commitment is one main element which is essential for collaboration. Since we identified the synergy that could be generated by consciously intervening and change any factor, it is imperative that any positive change in the fundamental elements will positively affect the system as a whole. Focused attention on the main three factors and the fundamental elements behind those factors will enable the creation of a vibrant innovation ecosystem within the firm as well as in the regional and national level ecosystems.

8.2 Organisational Capabilities

According to David Teece, organisations must be able to continuously sense and seize opportunities and to periodically transform the organisation and culture to suit the emerging scenarios (Teece, 2018). An enterprise with strong dynamic capabilities will be able to renew resources and capabilities to innovate and respond to changing market conditions. Dynamic capabilities are the ability of a firm to reconfigure existing capabilities to provide long term competitive advantage. It

determines the ability of a firm to compete simultaneously in both mature and emerging markets. New Zealand firms should develop these capabilities in order to thrive domestically as well as in the export market.

Characteristics that describe design thinking correspond to important mindset considerations for innovation, including user centric, cross-disciplinary, collaborative and holistic (Liu & Mannhardt, 2019). Design thinking capabilities will improve the creative problem solving abilities in an organisation. This will also help them to think in terms of user experience and empathise with the customer. These are much needed skills in the knowledge economy and in collaborative innovation.

Important things for innovation to occur are diversity of knowledge, better dissemination and responsiveness of the organisation. Risk taking, higher aspiration level and long term focus along with motivated innovation champions are needed for successful innovation at a firm level. The more responsive and agile an organisation is the more likely it is to be innovative. Absorptive capacity could become a potential source of competitive advantage. The firm that has a large knowledge base is well equipped to understand new scientific knowledge and its commercial applicability.

Ensuring research institutions face less barriers to sharing resources and infrastructure will help them form a coordinated, dynamic network of research activity and support (MBIE, 2019d). The system needs strong connections between the various players to encourage collaboration and engagement. Stronger connections allow an easier flow of people, knowledge, capabilities, funding, and capital within and across the innovation ecosystem.

Open innovation assumes that the sources of knowledge for innovation are widely distributed in the economy (Chesbrough & Bogers, 2014). Participation in global value chains can build capabilities and also provides opportunities for firms to specialise in niche products and so raise productivity (New Zealand Productivity Commission, 2021). Instead of depending too much on inhouse R&D, New Zealand firms should open up and embrace collaboration with worldwide partners.

8.3 Future Foresight: New Zealand innovation ecosystem

New Zealand takes a very conservative approach to investing in science and has a very low tolerance for failure(Hendy, 2013). There is low tolerance for risk taking and creative destruction is not allowed. Being more comfortable with trying new things should be the way forward. The cultural perception has to change to view the country as an exporter of knowledge rather than nature. An open culture in R&D should be encouraged so that connectivity and diversity of ideas can flourish.

Innovation will be the main mechanism for improving New Zealanders' productivity, prosperity and wellbeing. Creating a more productive New Zealand economy will require a restructuring towards knowledge intensive sectors, such as high-technology manufacturing, as well as an increase in productivity across all sectors of the economy (MBIE, 2015).

New Zealand's levels of productivity and income may not support the general level of wellbeing the country aspire for the future (Future of Work, 2019). The OECD looked into the productivity paradox and attributed it to the lack of international connections, weak competitive pressures, low rates of capital investment and less R&D investment (PMBAC, 2019). Strengthening knowledge diffusion within the economy, improvements in research-industry linkages and stronger mobility of human resources within the economy is needed. Improving New Zealand's international engagement is core to any material improvement in national productivity performance (Skilling, 2020). It needs dense clusters in which New Zealand firms can get to scale through exporting goods and services as well as outward direct investment.

Average life satisfaction is higher in countries with higher per capita GDP (Sacks, Stevenson, & Wolfers, 2010). As a general principle, innovation and economic growth increases wellbeing because living standards rise. If New Zealand does not lift its productivity growth, the economic growth will decline and result in stagnation of growth and will put a strain on the nation's social fabric (PMBAC, 2019).The gap between small economies that invest a lot in R&D and others who invest less has been widening over the past decade (Skilling, 2020). New Zealand's R&D investment needs to be increased to at least 3% of GDP compared to the current 1.4%.

There is an opportunity for New Zealand to make the tech industry the largest export earner in the country and hence transform the economy (Hendy, 2013). This will see an increase in productivity and contributes to the prosperity of the nation. For New Zealand innovation ecosystem to successfully emerge, it requires crossing a threshold of critical mass. The size, scalability and geographical factors are important challenges to overcome. At the same time, several small advanced economies have faced these challenges and became successful. It requires more investment in R&D, diversifying exports, encourage industries which can produce more value added products and services and improve the collaboration and knowledge sharing culture in the economy.

Government must take deliberate steps to upgrade New Zealand's innovation ecosystem and support the export of goods and services with a unique competitive advantage. Building an innovation ecosystem with deep networks between industry, researchers and government can help

provide the scale needed to innovate and export (New Zealand Productivity Commission, 2021). Focused innovation effort across government, industry and research organisations is required.

International engagement is the productivity growth engine of firms and the overall economy in small advanced economies like New Zealand (Skilling, 2020). New Zealand's weak productivity performance and the absence of frontier firms is largely due to constraints on firms developing competitive advantage in global markets. A structural policy change is required and a firm-based approach to developing an agenda focusing on building competitive advantage through deep investment in skills, knowledge and innovation is needed.

"As the Fourth Industrial Revolution unfolds companies are seeking to harness new and emerging technologies to reach higher levels of efficiency of production and consumption. Skills such as creativity, originality and initiative, critical thinking, persuasion and negotiation will increase their value in the new age." (WEF, 2018).

The fourth industrial revolution and new digital technologies are disrupting traditional industries. The nature of work is being profoundly affected by artificial Intelligence, machine learning and automation. From the perspective of an organisation, different automation solutions decrease low value repetitive tasks and release time for more value creating activities. The numbers of displaced workers are expected to increase significantly as more and more complex tasks are automated. Skill training and enhancing competencies are required in this new age of automation (Future of Work, 2019).

Emotional intelligence, leadership and social influence are skills which will see an increase in demand. There are four types of work activities that will see an increase in demand: working with machines (technology skills), applying expertise (cognitive skills), interacting with stakeholders (collaboration skills), and managing and developing people (emotional skills) (PMBAC, 2019). Countries must prioritise skills training and prepare its citizens to embrace the next change. Government policy must encourage innovation, give appropriate signals to the businesses and fund skills training which can have a major influence on economic growth (MBIE, 2019b).

Countries that engage with their expat communities can harness new opportunities in trade and investment. New Zealand has the second largest offshore population among the OECD countries (KEA NZ, 2020). Kea is a network of global Kiwis who are actively engaged and passionate about the

future of the country. The mission is to drive high impact connections for Kiwis around the world and at home. According to Davenport, it is important to work closely with expatriate talent pool and encourage overseas New Zealanders to regard themselves as part of one team (Davenport, 2004).

Every nation is competing for talent and in the knowledge economy there is a level playing field and New Zealand is no longer in a position to complain about geographic isolation. It has to increase its share of R&D spending so as to have a significant impact. New Zealand is currently an attractive destination internationally and policy needs to use that advantage to more clearly target high-skilled migrants. The strategy should be to develop a knowledge-based economy in New Zealand.

8.4 Knowledge Economy

New Zealand brand has served well in promoting tourism, education and immigration (BGA, 2017). The country must build on the reputation and project itself as a knowledge economy. Doubling or tripling the contribution of dairy or tourism is not the way forward for NZ, given their respective demands on land, water and infrastructure and their poor productivity returns (Callaghan Innovation, 2017). New Zealand should build on its knowledge and innovation system for exporting higher value export products and decouple growth from natural resource use (OECD, 2019a). Knowledge based exports could generate significant earnings without consuming energy, affecting the environment or needing complex regulation (Callaghan Innovation, 2018). Innovation including R&D can boost firm productivity and there can also be knowledge spillover benefits beyond individual firms.

New Zealand needs to diversify into knowledge economy while keeping the farming advantage. Innovations and R&D in agritech and cleantech, deep technologies like medtech and biotech and ICT should be the way forward to create more economic value, productivity and prosperity for the country. As a small advanced economy New Zealand has the potential to evolve naturally and produce niche innovations. This has been proven by examples of Buckley Systems, Gallagher, Lanzatech, Fisher& Paykel Healthcare, PowerbyProxi, Rocketlab and Soul Machines. A good innovation ecosystem can accelerate the progress and make New Zealand a top innovating nation.

> "New Zealanders work about 10% more hours than the OECD average to produce about 20% less. This has to change and the country should learn to work smarter." (New Zealand Productivity Commission, 2021)

The economic value of knowledge is greater than its market value. Countries create new areas of comparative advantage by building on and extending existing knowledge and capabilities. A nation's investment in R&D and knowledge capital determines productivity growth and hence long term prosperity. Investing in knowledge will have a multiplier effect through knowledge spillover or diffusion of knowledge and hence more return on investment. Domestic R&D will also ensure that there is enough absorptive capacity to receive outside knowledge.

Investment in skills, organisational capabilities and managerial ability are important in improving firms' absorptive capacity to benefit from new knowledge (Conway, 2018). Develop a science and innovation system that is open and responsive to new opportunities and focused on creating vibrant innovation ecosystems in areas appropriate for New Zealand's economic geography (Conway, 2018). Increase collaboration between research organisations and firms and improve management practices so that it increases overall knowledge diffusion in the ecosystem.

Increased productivity means the ability to create more economic value out of the same amount of work by extracting value from ideas, creativity and through automation. Innovation and technology adoption can improve productivity and hence contribute much into the country's economy. For this to happen protectionism has to stop and creative destruction needs to be encouraged. Also, more productive sectors like high-tech industries should be an important part of the economy.

Tomorrow's growth economies will be determined by today's investments in science, technology, engineering, and mathematics (STEM). The gap between New Zealand and the rest of the OECD countries is a knowledge gap. Countries that rely solely on the market to provide science and technology will be left behind by those with governments that invest in knowledge. New Zealand needs to invest more in science and research and perceive themselves as people of knowledge and not just people of nature.

There is a broad international policy consensus that research, science and innovation are key drivers of economic development and social progress (MBIE, 2019c). They are critical to sustaining productivity growth, technological change and tackling social and environmental problems. Adam Jaffe argues that a state that improves its university research system will increase local innovation both by attracting industrial R&D and augmenting its productivity (Jaffe, 1989). A robust, resilient and adaptive RSI sector has a critical role to play in driving the transformational change needed in the New Zealand economy (MBIE, 2020b). There also needs to be collaboration to ensure synergies between different research institutes, university research and various ministries. Growing own

research capability and having international linkages will be essential if New Zealand is to build a more resilient RSI sector.

Universities need to think more in terms of applied research and commercialisation. They shouldn't insist on taking too much ownership and control of the IP or start-ups which are formed out of university research and commercialisation. The apparent lack of engagement between both the parties shows a major missed opportunity. There is knowledge and expertise available at both ends but without sharing there is no real contribution to the innovation ecosystem. Open innovation strategies should be encouraged between firms, universities and research centres.

New Zealand should increase the number of international research and development collaboration agreements in strategic areas for the high value manufacturing and services sector (Raine et al., 2011). This sector will increase the diversity and overall value of exports and contribute to the growth of new skills and capabilities in the country. New Zealand should prioritise areas of the sciences where it is capable of playing a leading role given its capital and capability base and where there is the potential to deliver advanced technology products. It should maintain its commitment to basic and applied research but give more emphasis to engineering and the physical sciences.

8.5 Innovation Policy

A country that relied only on contracting to commercialise its science outputs would be positioning itself as a commodity provider of scientific research and innovation (Boven, 2009). New Zealand must form and grow more successful international businesses if it is to extract the maximum commercial and economic value from its publicly funded scientific research. The higher rate of innovation would lift productivity and improve the competitiveness of the export sector. Government policy should be targeted at activities and investments that have the clear potential to provide knowledge spillovers and solve barriers for collaboration.

Lack of R&D and innovation strategy is the main reason behind the inability of firms to interact with other ecosystem partners. Changes to investment processes to reduce administration and operational costs would free up funds for research and also valuable time (MBIE, 2020b). There is opportunity to review and improve the efficiencies of these instruments. Callaghan innovation has various schemes to help with R&D in firms, but these are not utilised fully by established firms. There needs to be an increased focus with supporting agencies and other partners in the innovation ecosystem.

Policies focused on strengthening business networks and links with research institutions have positive impacts on firm-level collaboration and innovation. New Zealand's innovation ecosystems

are not currently working well for actual and potential frontier firms. The links between firms and public research institutions are mostly poor, and research is too focused on science excellence rather than impact and responding to industry needs. New Zealand Productivity Commission recommends greater collaboration between government, industry and researchers on innovation policy and investments.

Innovation policy needs to have a relentless focus on supporting world-leading ecosystems of firms. Invest in building "innovation ecosystems" around the frontier firms, in selected focus areas. These ecosystems are made up of different entities and the networks between them. Building deep innovation ecosystems will help attract and retain large firms and top talent. New Zealand can learn from other small advanced economies to grow frontier firms by surrounding them with world-class innovation ecosystems. Building world-class innovation ecosystems will also require the private sector having the capacity, capability and willingness to collaborate.

The innovation ecosystem must be nurtured and refreshed to succeed in a rapidly changing world. For a country like New Zealand, which doesn't have a huge domestic market, it is very logical for firms to collaborate in order to fast track its innovation process. The solution is to give incentives for collaboration and knowledge sharing through policy interventions. Collaboration champions are to be identified and nurtured in all ecosystem entities. Clear commitment from government, industry and research institutions is required and policy levers should be there to incentivise different players in the innovation ecosystem.

Collaboration between research institutions and industry should be improved as part of a focused innovation policy. The country needs to frame policies which will help align the academic and industry objectives while at the same time give importance to student career. Government needs to provide some investments at the early stage in the process in grooming the talent for the future rather than just spending money at the end of the process through seed investment. The educational system needs a transformational change and the talent produced should have opportunities in NZ. There is a need to create a positive cycle of activities which will ultimately benefit the innovation ecosystem in NZ.

New Zealand's innovation policy has not paid enough attention to innovation ecosystems. The Government must develop a clear innovation strategy and take deliberate policy steps to upgrade New Zealand's innovation ecosystems. Collaboration between research institutions and industry for the purpose of developing skills should be improved and scaled up as part of a focused innovation policy process. Tangible steps need to be taken in order to create synergy of activities

within the innovation ecosystem in alignment with culture, collaboration and knowledge sharing factors.

8.6 Summary

The participatory action research on the case study firms showed that factors such as culture, collaboration and knowledge sharing are of prime importance while setting up an innovation ecosystem. These factors influence each other, and external interactions can have a positive effect on creating a dynamic internal innovation ecosystem. From the case study observations and data, as well as the literature shows there needs to be some fundamental elements to create a dynamic innovation ecosystem in a firm. The main elements are trust, communication, absorptive capacity, knowledge spillover and commitment.

The cultural perception in New Zealand has to change to view the country as an exporter of knowledge rather than nature. An open culture in R&D should be encouraged so that connectivity and diversity of ideas can flourish. Innovation will be the main mechanism for improving New Zealanders' productivity, prosperity and wellbeing. Strengthening knowledge diffusion within the economy, improvements in research-industry linkages and stronger mobility of human resources within the economy is needed. A structural policy change is required and a firm-based approach to developing an agenda focusing on building competitive advantage through deep investment in skills, knowledge and innovation is needed.

New Zealand needs to diversify into knowledge economy while keeping the farming advantage. Innovations and R&D in agritech and cleantech, deep technologies like medtech and biotech and ICT should be the way forward to create more economic value, productivity and prosperity for the country. Increase collaboration between research organisations and firms and improve management practices so that it increases overall knowledge diffusion in the ecosystem. There also needs to be collaboration to ensure synergies between different research institutes, university research and various ministries. Growing own research capability and having international linkages will be essential if New Zealand is to build a more resilient RSI sector.

The higher rate of innovation would lift productivity and improve the competitiveness of the export sector. Government policy should be targeted at activities and investments that have the clear potential to provide knowledge spillovers and solve barriers for collaboration. New Zealand's innovation ecosystems are not currently working well for actual and potential frontier firms. The links between firms and public research institutions are mostly poor, and research is too focused on science excellence rather than impact and responding to industry needs. Invest in building

innovation ecosystems around the frontier firms, in selected focus areas. These ecosystems are made up of different entities and the networks between them. Building deep innovation ecosystems will help attract and retain large firms and top talent. Clear commitment from government, industry and research institutions is required and policy levers should be there to incentivise different players in the innovation ecosystem.

9.0 Conclusion

Economic growth of a nation in the age of knowledge economy is driven by innovation and technology which enable higher value output and hence productivity gains. Innovation needs an environment suitable for it. Innovation ecosystems are important to create the right partners and conditions for them to work together. The ecosystem may consist of both networks of multiple firms and individuals who are participating through different interaction mechanisms. Relationships and interactions between innovation ecosystems need to be analysed at several levels in order to understand linkages between them in the real world.

The study of innovation ecosystems and New Zealand firms have revealed the main factors that are essential for a dynamic firm level ecosystem and also the organisational characteristics which are required. The study throws light on the influence of national culture, values and mindset on the regional as well as the firm level innovation ecosystems. It showed the importance of collaboration and knowledge sharing at the national, regional and organisational level. In order to improve the innovativeness of firms and the commercialisation of research, it is important to strengthen the interactions between actors in the ecosystem. These interactions can generate a synergy and cycles where one factor can positively affect other factors, all contributing to innovation and growth.

Collaboration between industry partners as well as university research collaborations have worked well in some of the successful innovation hubs around the world. Silicon Valley and Scandinavian countries are a good example of this as discussed in chapter 6. The successful collaboration between Stanford University, University of California Berkeley and the semiconductor industry has powered the Silicon Valley innovation engine in its early stages and supported the Valley throughout its transformations into computer, big data, social media and internet of things (Saxenian, 1996). There are other examples from Europe, Latin America and Asia where firms have positioned themselves to tap into the geographical innovation eco system and frame an internal innovation eco system to maximise the benefits.

To prosper in the new global economy we need scientists, engineers and entrepreneurs who work collaboratively not only within the country but globally. Internationalisation is critical for the performance of a small open economy and its innovation system. Innovation and growth would be favoured by an ecosystem that is internationally linked and connecting new firms to large markets will provide a base for scaling up. International linkages are also an effective way to increase the returns of research. Incentives for radical innovation should be strengthened through cross-sectoral collaboration and better industry-science linkages for research and commercialisation.

9.1 Contributions to Knowledge

This study gives a new perspective on innovation ecosystem in New Zealand firms, and it has four major contributions to research.

1. Formation of internal innovation ecosystem in firms.

The study of innovation ecosystem and the interaction between firm, regional and national level ecosystems have found some important findings pertinent to the creation of innovation environment anywhere. It is possible to initiate and manage ecosystems through conscious interventions and is important to consider the system view of firm level innovation and also to look at the big picture of regional and national level. The ideal way an organisation position itself to tap into the external innovation ecosystem and frame its internal ecosystem is a topic of interest to many firms.

The study finds that ecosystem mindset can be implanted in a firm by focussing on three fundamental factors namely culture, collaboration and knowledge sharing. There is inherent influence between these factors and any one of them can induce a change in other factors. This will create a positive loop and further strengthen the ecosystem. The study shows a way of generating a dynamic innovation ecosystem in firms through effective interactions within the firm and also external to the firm.

2. Synergy between internal and external interactions.

The research study looks at the innovation capability of the organisation and sees the opportunities to interact with ecosystem partners in a dynamic and constructive way. Organisations can develop an internal innovation eco system through effective interaction with the external environment and vice versa. By creating an ecosystem mindset there is a high probability of synergy between internal and external innovation ecosystem. Various elements such as trust, communication, commitment, absorptive capacity and knowledge spillover are found to be key in creating a vibrant innovation ecosystem. Trust and communication are the basic elements which are needed for all the three factors namely: culture, collaboration and knowledge sharing.

External interactions of collaboration and knowledge sharing will demand an internal culture of cooperation and openness. It requires dynamic leadership, management willingness and champions to lead the culture change. Absorptive capacity and knowledge spillover are other main elements which are required for knowledge sharing which subsequently help with collaboration

and culture change. We found that there is a network of interactions happening at the firm level ecosystem, between the firm level and regional level, among regional ecosystem partners, between regional and national level ecosystem and within various partners in the national innovation ecosystem.

3. National innovation policy and its influence on organisation level.

The third main contribution of this study is the impact of the country's economic policy on the regional and firm level innovation ecosystem. As a small advanced economy New Zealand is doing well in terms of the institutional framework but is struggling to maintain its position among the leading innovative countries. Over dependence on the commodity export has negatively impacted the country's advancement in the knowledge economy. Under investment in R&D has put the country under a commodity trap. Conscious effort is needed to get the country out of its commodity addiction and diversify its export portfolio. A national level innovation strategy and alignment of industry and government policy is needed.

New Zealand is not making progress at a rapid rate and at nearly the same rate as other small advanced economies. Other countries have moved to higher technology and higher value added products which create more productivity and hence more prosperity. Kiwis underachieve in creating large sustainable businesses that can ensure prosperity and economic growth. The country requires a clear innovation leadership, a cultural change through a strong national science and innovation policy, more collaborative approach to knowledge transfer and commercialisation and a step change in ambition and aspiration.

9.2 Limitations

The study of innovation ecosystems and New Zealand firms have three main limitations.

1. Bias towards larger firms.

The study mainly focused on two big firms from the New Zealand and tried to extrapolate the findings as a general observation on New Zealand firms. It would have been better to include some small firms and start-ups in the case studies. This was done mainly because of the time constraints and the adoption of participatory action research methodology which required more in-depth analysis of the case study firms. Getting firms to agree on the participatory action research also limited the available options.

2. Case study firms located in Auckland region.

Both the case study firms are located in Auckland regional ecosystem and it is not fair to extrapolate the findings to a general New Zealand context. Auckland region is the main financial and industrial capital of New Zealand and since it already has a vibrant innovation ecosystem compared to many other regions in the country the observations may be biased. The general findings could be common phenomena for firms and independent of regional influence. The researcher's ability to find firms willing to participate for the research and the in depth analysis was limited to the Auckland region.

3. The lower number of case study firms.

The study focuses on participatory action research on two big firms in New Zealand and generalise the findings for ecosystem characteristics in New Zealand firms. Survey and interview data are collected from around 20 participants in either firms and it is combined with observations and participatory action research which is a more in depth analysis on the firm and the ecosystem. The two firms could be considered as true depictions of New Zealand organisations and insights from the findings could give a general tendency of New Zealand firms.

9.3 Future Work

As for the future research opportunities, it would be good to have more data from New Zealand businesses and ecosystem partners to validate the three innovation ecosystem factors which are found as part of this study. It would also throw more light on the fundamental elements which are required to create the right conditions for innovation ecosystem. More survey and interview data as part of a qualitative study will help with this. Undertaking of quantitative study to look at the degree of influence of the three main factors from this study is also a possibility. The amount of change of each factor through influence from other factors and the direct causality of each interaction can be found out through quantitative study.

As mentioned before, studies based on innovation ecosystem is a recent phenomenon and a deeper study at the firm level to see the exact causality of actions could be conducted. Studies could be done to see the effect of different fundamental elements like trust, communication, commitment, absorptive capacity and knowledge spillover on the three factors and its dynamic nature. There is scope for a quantitative analysis of innovation ecosystem elements and its correlation.

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Appendices

Appendix 1. Ethics Approval Document

Research Office
Post–Award Support Services

The University of Auckland
Private Bag 92019
Auckland, New Zealand

Level 10, 49 Symonds Street
Telephone: 64 9 373 7599
Extension: 83711
Facsimile: 64 9 373 7432
ro-ethics@auckland.ac.nz

MEMORANDUM TO:

Prof Xun Xu
Mechanical Engineering

Re: Application for Ethics Approval (Our Ref. 020826): Approved with comment

The Committee considered your application for ethics approval for your study entitled **Multi-perspective Innovation Capability Assessment Tool**.

Ethics approval was given for a period of three years with the following comment(s):

1. Please clarify in the participants PIS that it is the company has given their assurance that participation or none participation will not affect their relationship or employment with the organisation.

The expiry date for this approval is 01-Jun-2021.

If the project changes significantly you are required to resubmit a new application to UAHPEC for further consideration.

If you have obtained funding other than from UniServices, send a copy of this approval letter to the Activations team in the Research Office, at ro-awards@auckland.ac.nz. For UniServices contracts, send a copy of the approval letter to the Contract Manager, UniServices.

The Chair and the members of UAHPEC would be happy to discuss general matters relating to ethics approvals if you wish to do so. Contact should be made through the UAHPEC Ethics Administrators at ro-ethics@auckland.ac.nz in the first instance.

Please quote Protocol number **020826** on all communication with the UAHPEC regarding this application.

(This is a computer generated letter. No signature required.)

Department of Mechanical Engineering
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Private Bag 92019
Auckland 1142, New Zealand

Multi-perspective Innovation Capability Assessment Tool

Participant Information Sheet

Researcher*:* Pauls Davis
Supervisors*:* Professor Xun Xu, Dr. Mehdi Shahbazpour

Researcher introduction

Researcher 1*:* My name is Pauls Davis and I am a PhD student in the Department of Mechanical Engineering, at the University of Auckland, under the supervision of Professor Xun Xu and Dr. Mehdi Shahbazpour.

Project description

The main objective is to conduct innovation capability analysis of the organisation using a framework which is developed as part of a research at the University of Auckland. The assessment framework is looking at organization's innovation capabilities from 6 different perspectives. (Definitions included in the attached Glossary of terms document).

1. Innovation process (problem solving, internal dissemination, and project management)
2. Knowledge (knowledge acquisition, dissemination and responsiveness)
3. Organizational Structure
4. Control
5. Culture
6. Resources

Objectives

The research is looking at expanding the current framework and looking at innovation eco system on an organisational level. The aim is to understand the interaction of organisational internal dynamics with the external innovation entities like universities, research centres, start-up incubators and regional innovation centres.

Benefits

We expect that the results from this project will help to understand the interrelationship between external innovation entities and internal innovation eco system in firms. Also, we hope this research will benefit organisations to understand their innovation capability level and opportunities for creating a dynamic innovation culture. For the research participants, you will get to understand the firm's innovation capability level and more awareness of factors of innovation.

Potential risk

To the researchers' knowledge, there is no potential risk associated with this research.

Research result

A summary of the research findings will be made available to the particular organisation. Also, a copy of results will also be provided to participants. An aggregate data of the study will be published without any identifiable link to the individual participant or the organization.

Invitation to participate

Invitation to participate in the study will be send to a pool of potential participants identified by the organization. Participation is completely voluntary and anyone can decline this invitation to participate. Also, participants are free to withdraw from the study at any stage without having to give an explanation. The company has given their assurance that any decision to participate or not participate will not affect the individual's employment or relationship with the organisation in any manner.

Project procedures

Our research involves the usage of online questionnaire and a follow up interview.

1st round (45 mins). The participants will be asked to do an online questionnaire about the innovation capability level of their organisation.

2nd round (60 mins). The participants will be asked targeted questions based on their understanding of organisational capability and innovation in their particular area of business.

Data storage/retention/destruction/future use

The original research data will be retained for at least 6 years, and it will be stored in an electronic folder on the password-protected university computer. The folder will be encrypted to keep its confidentiality.

After the minimum storage time has elapsed, all the digital data will be deleted and cleaned from the university computer. All paper copies of information collected will also be shredded and destroyed.

Right to Withdraw from Participation

Participant can withdraw from the study at any stage without having to give an explanation.

Anonymity and Confidentiality

The preservation of confidentiality is paramount. The information shared with the researcher for the survey questionnaire and interview will remain confidential and can only be accessible by the researcher. If the information provided is reported/published, this will be done in a way that does not identify the source. Any other identifying information such as name, email and IP address will not be collected. Data will not be made publicly available on the Internet and there is no risk of identity being revealed in any public documents.

Contact details

Researcher:

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For any queries regarding ethical concerns you may contact the Chair, The University of Auckland Human Participants Ethics Committee, The University of Auckland, Research Office, Private Bag 92019, Auckland 1142. Telephone 09 373-7599 ext. 83711.
Email: ro-ethics@auckland.ac.nz.
Approved by the University of Auckland Human Participants Ethics Committee on 01 June 2018 for three years. Reference number 020826

Appendix 3. Consent form for participants

Department of Mechanical Engineering
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Auckland 1142
New Zealand

CONSENT FORM
(Participant)

THIS FORM WILL BE HELD FOR A PERIOD OF 6 YEARS

Project title: Multi-perspective Innovation Capability Assessment Tool

Name(s) of researcher(s): Pauls Davis, Mehdi Shahbazpour, Xun Xu

Contact email address for researcher(s): pdav121@aucklanduni.ac.nz

I have read the Participant Information Sheet, and I have understood the nature of the research and why I have been selected. I have had the opportunity to ask questions and have them answered to my satisfaction.

- I agree to take part in this research.
- I understand that my participation is completely voluntary and the company has given an undertaking that participation will not affect my relationship with the organisation in any way.
- I understand that I will be asked to do an online questionnaire and to be followed up with an interview about innovation capability in the organisation.
- I understand that all my data will be encrypted and kept in the university computer's R drive and my employer will not have any access to this data.
- I understand that I can withdraw from the study at any stage without having to give an explanation.
- I understand that an aggregate data will be published without any identifiable links to the individual participant or the organization.
- I wish to receive a summary of findings, which can be emailed to me at this email address:

_____

Name: _____

Signature_____ Date _____

Approved by the University of Auckland Human Participants Ethics Committee on 01 June 2018 for three years. Reference number 020826

Appendix 4. Innovation Capability Interview Questions

Section 1: General assessment of Innovation activities:

1. What does innovation mean to you and to the business?
2. What does innovation look like when you see it in your role?
3. What impact does innovation have on your work?
4. What is difficult about innovation? What is missing in your area that would make innovation happen?
5. Do you have any experience on innovation projects? Can you share project aim, deliverables, approach and success factors?
6. Did your group use any framework or special management tools to assist with innovation projects?
7. Does regulation affect the change dynamics or innovation in your area of work?
8. What do you think are relevant organisational changes required for innovation to happen in your organisation?

Section 2: Collaboration:

1. Have you been involved in collaborative projects in your organisation?
2. What do you think are the success factors for internal collaboration?
3. How effectively your organisation collaborates with external entities?
4. What do you think are the barriers for external collaboration?
5. Are the employees willing to seek input from outside their organisational unit?
6. Is there a prevailing attitude that people ought to fix their own problems and not rely on help from others outside the unit?

Section 3: Knowledge Sharing:

1. How effective is the knowledge sharing infrastructure in the firm?
2. How easy or difficult is to find documents and information in the company's databases and knowledge-management systems?
3. Do employees resist to share their expertise and information for fear of becoming less valuable?
4. How easy or difficult is to locate experts in your company?
5. What are the current external knowledge sharing processes in place?
6. Do the firm have programs for teaching employees regarding knowledge sharing tools?

Section 4: Engagement:

1. What are the current organisational engagement programs in place?
2. Do your employees from different organisational units find it difficult to work together?

3. What are the success factors for engagement of teams during cross functional projects? Any examples?
4. How does the organisation deal with tough challenges regarding employee engagement?
5. What do you think are ways to engage more with the New Zealand innovation eco system?

Appendix 5. Innovation Capability Survey Questions

Process perspective

The process view of innovation is concerned about the sequence of activities through which inventive ideas are materialised into benefits for the innovators and the recipients of the innovation,
This self-assessment guide will help you assess your own organisational capability maturity in the areas of problem solving,
internal dissemination, and project management across three domains of technology, culture and process.

Problem-solving is a mental process to overcome obstacles and find a solution that best solves the problem. Innovation is at its core a problem solving process.

The characteristics of problem-solving mehods are :
• Systems approach to problem definition,
• Structured approach to analysis,
• Focus on elimination of root-causes.

domain	Key factors	Level 1	Level 2	Level 3	Level 4	Level 5
Process	Problem definition	Few problems are defined formally	Problems are often roughly defined	Problems are systematically defined	Problems are defined based on root-causes	Problem definitions integrate both soft and hard aspects
	Analysis	Focus on analysis of symptoms	Focus on analysis of root-causes	Focus on systematic root-causes analysis	Assumptions are systematically challenged	Analysis is systematic and holistic
	Finding solution	Mainly based on previous experience	Considering alternative solutions	Systematic Idea Generation and Evaluation approach	Combination of short term and long term solutions	Solutions targeting the elimination of trade-offs and root-causes
Technology	Problem-solving System	Mainly unstructured brainstorming	Structured and facilitated brainstorming	General tools are using .e.g. 8D, fish bone diagram, experimentation	Using problem solving systems such as, six sigma, TOC, TRIZ	Best practices tools and systems adjusted to fit the organisation
Culture	Attitude & regulations	Little awareness of problem-solving processes	Awareness about the importance of problem-solving	Encourage the take-up of best practice tools	Formal training in established problem solving methodologies	Culture for long term development and overcoming fundamental technical challenges

Similar format of capability matrix was used for Innovation Process, Knowledge, Structure, Control, Culture and Resources.

Appendix 6. University – Industry Collaboration Survey

These are the feedbacks from collaborative projects done with the University of Auckland students and case study firms in Auckland.

1. What is the motivation for collaboration with University?

2. Were the objectives of partnership clear in the beginning? How to balance risk if conditions change as the project progress especially with interim deliverables?

3. What additional value (which is not available within the industry) could be created by collaborating with universities?

4. What role does leaders or champions play in initiating this partnership? Or is it part of the HR policy of firms?

5. What worked and what didn't work in this particular project with University of Auckland?

6. Will interaction with external entities / groups change the internal dynamics in a firm? Any examples of positive changes?

7. What characteristics in a student group would be preferred by firm?

8. What level of interaction and communication is expected from the student group? What was the experience from this specific project?

9. What would be the success factors of successful collaboration between University and Industry? Any examples of assessing this within the firm?

10.For which type of projects the firm will be more inclined to engage with the University? Example: Problem Solving, process improvement, exploring new technologies, feasibility studies.